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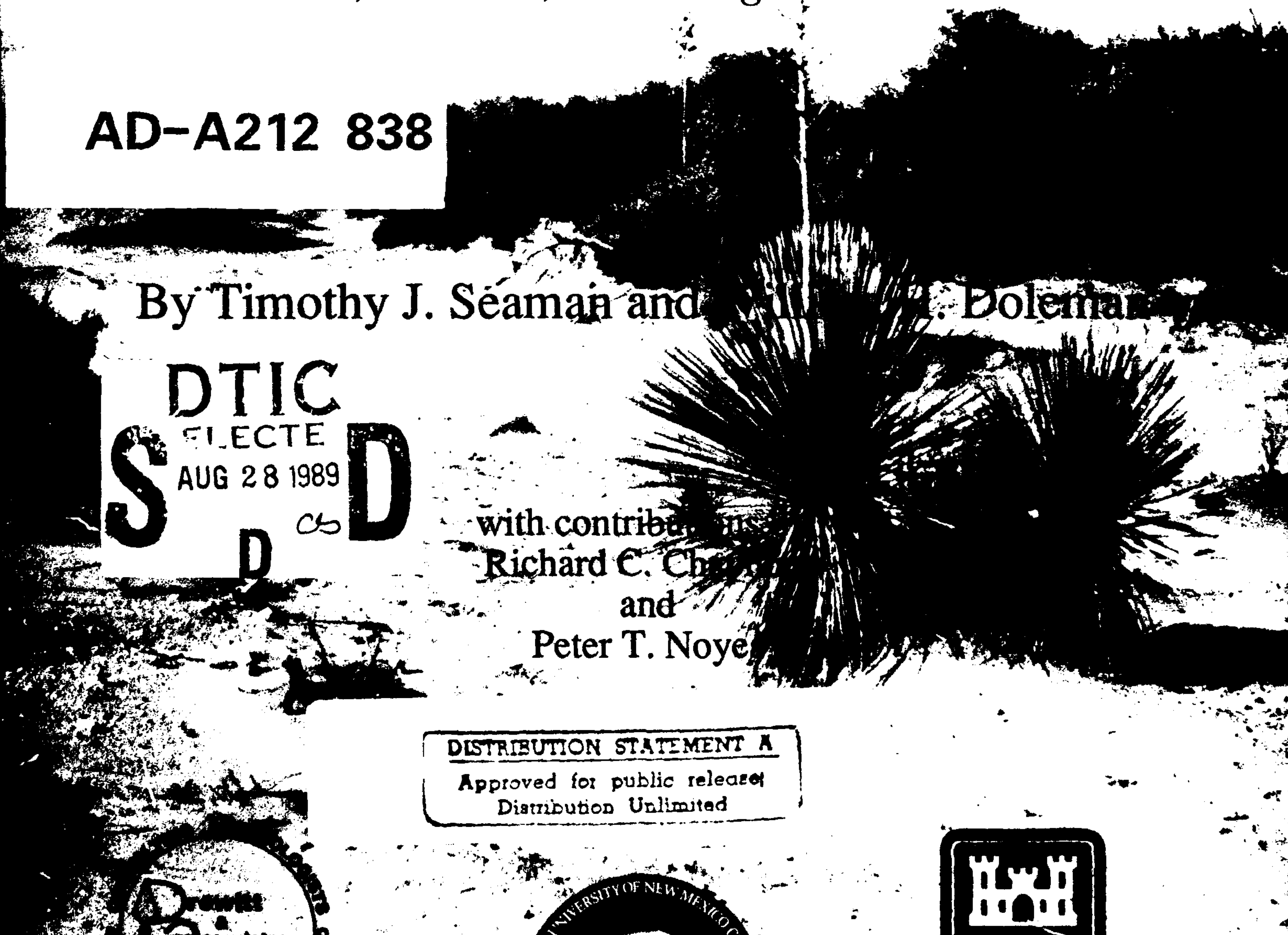
# The 1986 GBFEL–TIE Sample Survey on White Sands Missile Range, New Mexico:

## *The NASA, Stallion, and Orogrande Alternatives*





By Timothy J. Seaman and ... Doleman ...



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# THE 1986 GBFEL–TIE SAMPLE SURVEY ON WHITE SANDS MISSILE RANGE, NEW MEXICO

## *THE NASA, STALLION, AND OROGRANDE ALTERNATIVES*


by

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with contributions by

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# ABSTRACT

Three locations on White Sands Missile Range, New Mexico, are under consideration as alternatives for the proposed Ground Based Free Electron Laser Technology Integration Experiment (GBFEL–TIE). The study conducted jointly by Prewitt and Associates, Inc., and the Office of Contract Archeology, was designed to provide input into the GBFEL–TIE Draft Environmental Impact Statement concerning the potential impact of the proposed project on cultural resources in each of the alternatives. The input consists of a series of predictions based on data gathered from two sources: 1) a cultural resource sample survey (15%) of two alternatives conducted as part of this study, and 2) from a previous survey of the third alternative. A predictive model was developed and applied using these data that estimated the potential impact of the GBFEL–TIE facility on the cultural resources within each alternative. The predictions indicate that the NASA Alternative is, by far, the least favorable location for the facility followed by the Orogrande and Stallion Alternatives.

# ACKNOWLEDGEMENTS

As with most archeological projects, numerous people were involved in the successful completion of the GBFEL–TIE sample survey. The authors wish to thank the following individuals for their invaluable contributions to this report. The field crew worked many long, arduous hours under incredible time constraints and a fierce sun: Phillip Arnold, Mike Berman, Martha Binford, Jim Brandi, Glenna Dean (volunteer), Joanne Eakin, Janette Elyea, Pete Eschman, Peggy Gerow, Patrick Hogan, Signa Larralde, Peter Noyes, James Snyder, and Ron Stauber. Lenora Olson supervised data processing efforts and Pete Eschman maintained the input programs in addition to his field duties. Invaluable advice and direction were received from Robert Burton (Ft. Worth CE), Peter Eidenbach (WSMR Installation Support), and the project's co–principal investigators—Elton Prewitt (Prewitt and Associates, Inc., Austin), and Richard C. Chapman (OCA, Albuquerque). Considerable help in the various and often unanticipated logistics of field work was given by the staffs of the WSMR Installation Support Office, WSMR Range Control and Scheduling, and the Jornada Range Experimental Station. Without these people and organizations, we would still be lost in the desert.

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Chapter 1

# INTRODUCTION AND BACKGROUND INFORMATION

## Introduction

Between 9 June and 4 August, 1986, Prewitt and Associates, Inc. (PAI), and the Office of Contract Archeology, University of New Mexico (OCA) conducted an archeological survey of a 15% sample of two parcels of land, each measuring approximately 2 x 10 mi (3.2 x 16.1 km), located within White Sands Missile Range, New Mexico. The survey was performed for the U.S. Army Engineer District, Ft. Worth as Contract No. DACW63-86-D-0100, Delivery Order No. 4 to facilitate siting of the proposed Ground Based Free Electron Laser Technology Integration Experiment (GBFEL-TIE), a Strategic Defense Command project. Archeological data collected from the sampled portions of the two areas and from a third parcel, previously surveyed by OCA (Seaman et al. 1986) and also located on WSMR, were used in the development of a model predicting the nature and distribution of cultural resources in each area. This model and the collected data provided a basis for both evaluating the significance of known and suspected cultural resources within each area and assessing the potential impact of the planned laser facility on those resources.

This document represents the final report of findings for the GBFEL-TIE cultural resources sample survey. The partial results of the sample survey and preliminary predictive statements were previously reported in a document submitted to the U.S. Army Corps of Engineers (CE), Fort Worth District, on 15 July 1986, for inclusion within the Draft Environmental Impact Statement (U.S. Army Strategic Defense Command 1986) issued in September, 1986.

This introductory chapter will provide a brief description of the three GBFEL-TIE alternatives in terms of their environmental parameters, culture history, and previous archeological research.

## Environmental Background

The GBFEL-TIE alternatives are located within major internally drained basins surrounding the San Andres and Oscura mountains of south-central New Mexico (Figure 1.1). The NASA Alternative is located immediately below the western base of the San Andres mountains on the alluvial fan draining into the Jornada del Muerto. The Stallion Alternative is also located within the Jornada del Muerto, at the northernmost extent between the highlands formed by Chupadera Mesa and the Oscura mountains, and the breaks of Rio Grande Valley. The Orogrande Alternative is located in the southernmost portion of the Tularosa Basin, on the lower portions of the alluvial fan and on the basin floor west of the Jarilla mountains, a low isolated range.

These large basins are located within the northernmost extent of the Chihuahuan Desert Region. The Chihuahuan Desert encompasses an area that extends southward from about Socorro, NM through Trans-Pecos Texas and into Mexico to Zacatecas (some 800 km). Located primarily between the two major mountain masses in Mexico (the Sierra Madre Occidental and the Sierra Madre Oriental), the Chihuahuan Desert is one of the highest North American deserts. The GBFEL-TIE alternatives are located within an extension of this region which follows the Rio Grande Valley northward between the Sacramento and Gila mountain masses.

Northern Chihuahuan desert vegetation communities are commonly treeless, dominated by xerophytic shrubs such as creosotebush, tarbush, and yucca. At higher elevations in the mountain foothills, a variety of cactus species and leaf succulents (e.g., agave, sotol, ocotillo, and prickly pear) commonly replaces many of the shrub species in terms of dominance. Mesquite is the major tree species in parts of the Jornada del Muerto and in virtually all of the southern Tularosa Basin and Hueco Bolson. Mesquite trees, however, grow much like a low shrub on the sandy basin floor, catching wind-blown sands to form large expanses of coppice dunes.

## Regional Culture History

The prehistory of south-central New Mexico can conveniently divided into two major stages: the Preformative and Formative. The Preformative begins with the initial human occupation of the region by Paleoindian populations beginning around 10,000 BC and lasting until perhaps 6000 BC [Beckett 1983; Human Systems Research (HSR) 1973]. The Paleoindian period of the Preformative stage is divided into a number of temporal subdivisions based on diagnostic projectile point styles (e.g., Clovis, Folsom, Plainview) and represents a series of similarly organized adaptations to terminal Pleistocene environmental conditions very different from the present. These are often described as focal economies based largely on the hunting of extinct Pleistocene fauna, although present knowledge of this period is believed by many to overemphasize hunting activities as compared with other subsistence pursuits.

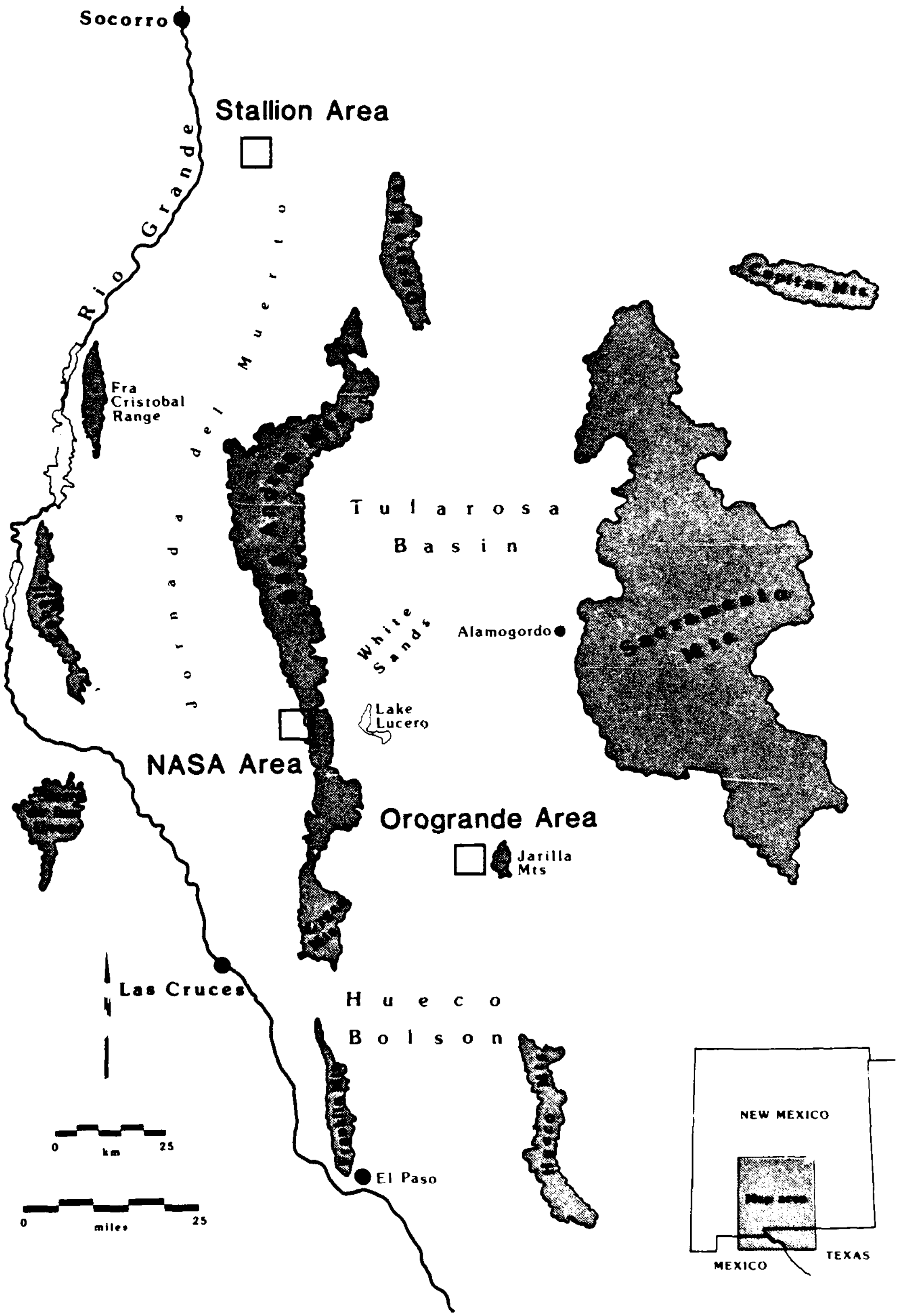



Figure 1.1 Regional map of alternative area locations

During the following Archaic period, there is a gradual shift or transition from focal economies to more broad spectrum adaptations in which gathering of a wide variety of wild plant resources was emphasized at the expense of hunting. Presently, this period of the Preformative stage in south–central New Mexico is very poorly understood and, without chronometric dating, there is little basis for the identification of temporal subdivisions (e.g. early, middle, late) within the Archaic. Beckett (1979) has suggested that, in cultural–historical terms, the Archaic period in the Jornada Mogollon region is related to both the Cochise and trans–Pecos Texas Archaic traditions, based on projectile point styles. By convention, the Archaic period terminates at about AD 200, coinciding with the occurrence of the earliest dates for ceramics and, by association, agriculture.

The Formative stage cultural–historical framework, which is most relevant to the GBFEL–TIE alternatives, was initially formulated in 1948 by Donald J. Lehmer (Lehmer 1948). In his definition of the Jornada branch of the Mogollon, Lehmer outlined a series of four phases along with their diagnostic attributes: the very poorly defined Hueco phase, the Mesilla phase (AD 900–1100), the Doña Ana phase (AD 1100–1200), and the El Paso phase (AD 1200–1450). Aside from the abandonment of the Hueco phase (Beckett 1979), revisions to Lehmer's basic scheme have been limited to adjustment of the Mesilla phase beginning date to AD 200 to correspond to the earliest dated pottery, and the division of that phase into Early (AD 200–750) and Late (AD 750–1100), based on the presence of various Mimbres whitewares.

During the Formative stage, a second major adaptational shift occurs with the development of agriculturally based subsistence economies. As is characteristic of developmental sequences throughout the American Southwest, the Formative stage involves increases in overall population density, decreasing mobility, narrowing of subsistence focus toward agricultural products, and many other concomitant technological and social changes. While it is probable that domesticated plants were present in the Jornada Region during the late Archaic period, the importance of agriculture is thought to be minimal during this period and through most of the Early Mesilla phase (ca. AD 200–750). Adaptations during this period are generally viewed as a continuation of the basic Archaic pattern of subsistence with the advent of ceramics having little import. During the Late Mesilla (ca. AD 750–1100) and Doña Ana (ca. AD 1100–1200) phases, there appears to have been a major increase in population and in relative dependence on agriculture along with a move toward an increasingly sedentary lifestyle. Although there has been some debate on this matter (Carmichael 1983), the El Paso phase (ca. AD 1200–1400) is traditionally viewed as the most complex period of Jornada Mogollon prehistory and as the period of greatest dependence on food production.

The Formative stage ends at about AD 1400–1450 with the abandonment of the El Paso phase adobe pueblos and virtually all agriculturally based adaptations in the internal basins of the Jornada Mogollon region. This collapse mirrors similarly timed events throughout the Southwest and is followed by a general movement towards major river valleys by some agriculturally dependent populations and the influx of historically documented hunter-gatherer groups.

## Previous Archeological Work

Previous archeological survey in and around the NASA and Stallion Alternatives has been extremely limited. Records of the Archeological Records Management System (ARMS) of the Museum of New Mexico indicate no previously recorded sites on the Cerro de la Compaña SE, Greens Baber Well, or Granjean Well Quads of the USGS 7.5′ series (Stallion Alternative). Additionally, no sites are listed for the Fleck Draw Quadrangle immediately north of the NASA Alternative. In all, seven previously recorded sites are within the boundaries of the Stallion and NASA Alternatives, however, none of these sites lies within any of the sample survey areas of this study.

Four previously recorded sites (Table 1.1) are located within or adjacent to the survey area boundaries of the Stallion Alternative. Two of these sites (LA 51271 and 51272) were recorded by Human Systems Research as part of the Headquarters Survey conducted for White Sands Missile Range (Kirkpatrick 1986). LA 51271, located on the northern boundary of the survey area, is described as an extensive lithic scatter containing five lithic concentrations and the remains of one possible brush shelter feature. LA 51272, also located along the northern border of the Stallion Alternative, is a small, sparse lithic scatter observable in blowouts in the local low sand dunes.

The two other sites located within the Stallion Alternative were recorded by the Agency for Conservation Archeology at Eastern New Mexico University in Portales. WS 244 and WS 245 are located using legal and narrative descriptions only. Both sites are aceramic lithic scatters without observed features. An apparent Archaic projectile point base fragment was collected from WS 245.

Additional archeological work in the vicinity of the Stallion Alternative includes the Headquarters Survey and ongoing work at the Mockingbird Gap Clovis period site by Robert H. Weber (Weber and Agogino 1968). Michael Marshall recorded an Elmendorf phase site at the top of Cerro de la Compaña as part of the Rio Abajo Archaeological Project along the lower Rio Grande (Marshall and Walt 1984). A check of the ARMS files revealed a few additional sites recorded by the Cultural Resource Management Division of New Mexico State University on BLM lands along US Highway 380, approximately 8 km

northwest of the Stallion Alternative. Additionally, three sites have been recorded by Rio Abajo Archaeological Services as part of a Mountain Bell right–of–way survey along the north side of US Highway 380.

In the NASA Alternative (Table 1.2) three sites are recorded within the boundaries of the survey area, as part of a series of seismic line surveys conducted by New Mexico State University. LA 35335 (NMSU 1100) is described as a lithic and groundstone scatter with at least one hearth exposed in a blowout. LA 35336 (NMSU 1101) is described as a lithic and ceramic scatter with at least 11 hearths. Ceramic types on this site include El Paso Brown, Chupadero Black–on–White, El Paso Polychrome, and Three Rivers Red–on–Terracotta. LA 35338 (NMSU 1103) includes several concentrations of ceramic, lithic, and groundstone artifacts and at least six hearths. Ceramic types include El Paso Brown and Polychrome, Mimbres Black–on–White, Three Rivers Red–on–Terracotta, Playas Red, and corrugated brownware. The seismic line survey recorded 15 additional sites within 5 km of the NASA Alternative (Table 1.2).

Additional work in the vicinity of the NASA Alternative was performed by Herbert W. Yeo of the Laboratory of Anthropology in Santa Fe, in 1950. Yeo recorded a series of four very large El Paso phase roomblocks on and near Cottonwood Draw, approximately 1 km south of the NASA Alternative. The number LA 175 was originally assigned to this series of ruins, but more a recent survey by Thomas O'Laughlin and Patrick Beckett, as part of the Doña Ana Archeological Project in 1968, redefined Yeo's work. A series of new site numbers—LA 9067, LA 9068, and LA 9069—was assigned to Yeo's roomblocks. The Cottonwood Springs Site is a very large pueblo located at Cottonwood Spring, east of LA 9067, and may also have been part of Yeo's LA 175, but this is not clear in the existing records of his work. Resurvey of this and other sites near Cottonwood Draw is believed to be necessary to resolve these identification problems.

Table 1.1. Previously recorded sites in the Stallion Alternative

| LA No. | Other No. | Recorded By | Lith | GrdSt | Cerm | Feat | Diag | Notes |
|---|---|---|---|---|---|---|---|---|
| N/A | WS 244 | Schermer, Brett Ruchensky, ACA | + | | | | | |
| N/A | WS 245 | ACA | + | | | | P | Point base |
| 51269 | HSR 8420-48 | HSR- Kirkpatrick | + | + | + | F | C | |
| 51270 | HSR 8420-49 | HSR- Kirkpatrick | + | + | | | | |
| 51271* | HSR 8420-50 | HSR- Kirkpatrick | + | | | H, S | P | Projectile point |
| 51272* | HSR 8420-51 | HSR- Kirkpatrick | + | | | | | |
| 51273 | HSR 8420-52 | HSR- Kirkpatrick | + | + | | H | | |
| 51274 | HSR 8420-53 | HSR- Kirkpatrick | + | + | + | F | C | El Paso Brown |
| 51275 | HSR 8420-54 | HSR- Kirkpatrick | + | | + | | C | El Paso Brown |
| 51330 | HSR 8420-55 | HSR- Kirkpatrick | + | | | | P | Jay point base |
| 51331 | HSR 8420-56 | HSR- Kirkpatrick | + | + | | | P | Jay point, Archaic point |
| 1080 | NM 02-0381 | OCA - Marshall | + | | + | S | C | Elmendorf phase |
| 26748 | AR NM 02-490 | Various | + | | | S | P | |

* within Stallion Alternative survey area

Key

| | | | |
|---|---|---|---|
| HSR | Human Systems Research | | |
| ACA | Agency for Conservation Archeology, Eastern New Mexico University | | |
| OCA | Office of Contract Archeology, University of New Mexico | | |
| Lith | lithic artifacts | GrdSt | ground stone artifacts |
| Cerm | ceramic artifacts | Feat | features (e.g., hearths) |
| Diag | diagnostic artifacts | Notes | comments on site records |
| + | present | C | ceramics |
| P | projectile point | F | fire-cracked rock |
| H | hearth | S | structure |

Table 1.2. Previously recorded sites in the NASA Alternative

| LA No. | Other No. | Recorded By | Lith | GrdSt | Cerm | Feat | Diag | Notes |
|---|---|---|---|---|---|---|---|---|
| 35332 | NMSU 1096 | NMSU--Duran | + | + | | | | |
| 35333 | NMSU 1097 | NMSU--Duran | + | + | | | | |
| 35334 | NMSU 1098 | NMSU--Duran | + | + | + | H | C | Jornada Mogollon |
| 35335 | NMSU 1100 | NMSU--Duran | + | + | + | H | C | El Paso phase |
| 35336* | NMSU 1101 | NMSU--Duran | + | + | + | H | C | Jornada Mogollon |
| 35337* | NMSU 1102 | NMSU--Duran | + | + | + | H | C | El Paso phase |
| 35338* | NMSU 1103 | NMSU--Duran | + | + | + | H | C | El Paso phase |
| 35339 | NMSU 1104 | NMSU--Duran | + | | + | H | C | Jornada Mogollon |
| 35340 | NMSU 1105 | NMSU--Duran | + | + | | | P | Archaic |
| 35341 | NMSU 1106 | NMSU--Duran | + | + | + | H | C | Jornada Mogollon |
| 35342 | NMSU 1107 | NMSU--Duran | + | + | + | H | C | Mesilla/Doña Ana |
| 35365 | NMSU 1130 | NMSU--Duran | + | + | | H | | |
| 35366 | NMSU 1131 | NMSU--Duran | + | + | | | | |
| 35367 | NMSU 1132 | NMSU--Duran | + | + | + | H | P | Chiricahua point |
| 35368 | NMSU 1133 | NMSU--Duran | + | + | | H | | |
| 35369 | NMSU 1134 | NMSU--Duran | + | | + | H | C | Jornada Mogollon |
| 35370 | NMSU 1135 | NMSU--Duran | + | + | + | H | C | Jornada Mogollon |
| 35371 | NMSU 1136 | NMSU--Duran | + | + | | H | | |
| 35372 | NMSU 1137 | NMSU--Duran | + | | + | H | C | Mesilla/Doña Ana |

* within NASA Alternative survey area

Key

| | | | |
|---|---|---|---|
| NMSU | New Mexico State University | | |
| Lith | lithic artifacts | GrdSt | ground stone artifacts |
| Cerm | ceramic artifacts | Feat | features (e.g., hearths) |
| Diag | diagnostic artifacts | Notes | comments on site records |
| P | projectile point | + | present |
| C | ceramics | F | fire-cracked rock |
| S | structure | H | hearth |

The Bruton Bead Site, located 5 km north of the NASA Alternative, was also the subject of recent research. This extremely large late Formative site was initially recorded as site number AR092 by the Center for Archeological Research, University of Texas at San Antonio, during the Radium Springs Survey (Hester 1977). In 1984, Michael E. Whalen resurveyed the Bruton Bead Site using an innovative method of test excavation in order to refine Hester's initial description of the site (Whalen 1985).

The majority of archeological research conducted in the vicinity of the Orogrande Alternative since 1970 has involved cultural resource inventories of large tracts of the basin floor and margins. In response to legislation of the early 1970s, which defined the responsibilities of Federal agencies concerning cultural resources, large-scale archeological surveys were performed on military reservations in the Tularosa Basin and Hueco Bolson. Surveys on the McGregor Guided Missile Range and the Doña Ana Range, east of the Orogrande Alternative, were conducted by the University of Texas at Austin (Beckes 1977; Beckes et al. 1977; Skelton et al. 1981), resulting in the inventory of 562 and 96 km$^2$, respectively. Part of the Fort Bliss Reservation (1466 km$^2$), located immediately to the south of the Orogrande Alternative, was also the focus of archeological surveys performed by the El Paso Centennial Museum (Whalen 1977, 1978, 1980, 1981; Carmichael 1981, 1983, 1984, 1985). Most recently, 225 km$^2$ on White Sands Missile Range were inventoried by the Office of Contract Archeology, University of New Mexico, for the Border Star 85 military exercises (Seaman et al. 1986). The Orogrande Alternative is located entirely within the Border Star 85 project area. To summarize, a total of 2349 km$^2$ have been inventoried in the immediate vicinity of the GBFEL-TIE Orogrande Alternative, with almost 10,500 archeological sites recorded (Table 1.3).

## Report Organization

The following chapter of this report will document the objectives of the GBFEL-TIE predictive modelling project and the field methods used in conducting the cultural

Table 1.3. Summary of large-scale inventories near the Orogrande Alternative

| Project | Area ($km^2$) | No.Sites | Reference |
|---|---|---|---|
| McGregor Guided Missile Range | 562 | 414 | Beckes et al. (1977) |
| Doña Ana Range | 96 | 19 | Skelton et al. (1981) |
| Fort Bliss Maneuver Areas 1-2 | 475 | 1835 | Whalen (1977, 1978,1980,1981) |
| Fort Bliss Maneuver Areas 3-8 | 991 | 6061 | Carmichael (1983) |
| Border Star 85 | 225 | 1908 | Seaman et al. (1986) |
| All Projects | 2349 | 10416 | |

resource survey. Chapter 3 summarizes the survey results in two of the three GBFEL–TIE alternatives and Chapter 4 presents the outcome of predictive analyses of these data and data from the Border Star 85 survey. Based on these analytical results, Chapter 5 provides an evaluation of National Register significance among cultural resources in each of the three alternatives and offers recommendations concerning the most favorable location for the GBFEL–TIE facility.

The report appendices provide supporting information on the design and implementation of the project and present the results of other activities, performed by PAI and OCA, which are related to this GBFEL–TIE sample survey. The initial CE Scope of Work for the project is reproduced in Appendix 1, while Appendix 2 presents the field recording forms and defines the variables and coding conventions. Monitoring activities, conducted concurrent with the GBFEL–TIE sample survey (Delivery Order #5; Contract No. DACW63–86–D–0010), are described in Appendix 3. Finally, an evaluation of Eidenbach's (1982) site significance evaluation scheme appears in Appendix 4, as requested by the Corps of Engineers.

Chapter 2

# PROJECT DESIGN

## Project Objectives and Scope of Work

The GBFEL–TIE cultural resources sample survey was designed to provide a basis for informed management decisions concerning the initial site selection for the GBFEL–TIE facility. Toward this end, the CE Scope of Work (reproduced in Appendix 1) provided for the archeological survey of slightly less than a 15% sample of two of the three candidate areas for the GBFEL–TIE facility and the development of a prediction model to estimate the potential effects of construction within each of the three alternatives. The model was to be based on analyses of the sample survey results for the NASA and Stallion areas and the results of a previous inventory of the Orogrande Alternative performed in 1984–1985 by the UNM Office of Contract Archeology (Seaman et al. 1986) for the Border Star 85 military exercises.

The CE Scope of Work also provided for the overall research orientation of the survey. An approach focused on extending two of the three research questions, initially addressed during the Border Star 85 survey (Seaman et al. 1986), was mandated in this document. The first area of research addressed in the Border Star 85 project concerned methodological problems involved in the identification and chronological control of Jornada Mogollon sites using assemblage data. The second centered on evaluating a series of models for Formative stage land use and subsistence based on data from Fort Bliss (Hard 1983; Mauldin 1984). Data collected during the Border Star 85 project formed the basis for the third area which was a statistical evaluation of archeological survey as a sampling technique and, more specifically, of nonsite survey strategies in general. The first two of these research questions guided the design of the GBFEL–TIE cultural resources survey and will be outlined in more detail below under "Problem Orientation".

## Project Schedule

It should be recognized at the outset that the combined effects of an extremely compressed project schedule and unexpectedly high site densities precluded extensive analytical consideration of the project research problems. To a large extent, this situation is due to the short time available for planning the survey and the fact that a preliminary report outlining survey results and recommendations was required almost immediately after the completion of field work. At the CE's request, a technical proposal and cost estimate were provided by PAI *before* the actual survey areas were identified; the reporting schedule necessitated hiring a very large survey crew and allowed almost no time for their training. The latter situation resulted in somewhat less consistency in data collection than would normally be the case. The report deadline also demanded that data processing activities (usually performed after fieldwork) be performed concurrent with the survey. With this restriction, there was little opportunity for modifying the initial survey and data recording system without delaying the process of data entry, editing, and preparation of the preliminary report.

The most serious consequence of the compressed time schedule concerns the abandonment of most of the project research goals. The failure of the CE to identify the location of target survey areas on WSMR prior to budgeting and preparation of the technical proposal by PAI made it necessary to compute an average survey rate based on previous survey on WSMR. As it became apparent that the site density in the NASA Alternative would require more than twice the anticipated survey effort, changes in project design were unavoidable. Data required by the research design simply could not be collected and/or analyzed without jeopardizing the management objectives and exceeding the strict timetable. When the seriousness of this situation became apparent, negotiations with the CE were conducted in an effort to reduce the survey sample for the NASA area rather than reduce the research effort. The result of these negotiations was that the CE directed PAI to allocate *all* project resources toward meeting management responsibilities, at the expense of attaining the originally stated research objectives. Thus, the following section of this chapter concerning the research goals is provided solely as rationale for the survey methods. It should be emphasized that the managerial needs of the project were attained on schedule.

## Problem Orientation

The problem orientation of this GBFEL–TIE predictive modelling project is derived from that of the Border Star 85 survey (Seaman et al. 1986). A detailed summary of the Border Star 85 research design is beyond the scope of this discussion and only the central points are considered here. The reader is referred to Chapter 2 in the Border Star 85 draft report (Seaman et al. 1986) for a complete description.

The major foci of both the Border Star 85 and GBFEL-TIE projects lie in two problems crucial to understanding Preformative and Formative stage adaptations in south-central New Mexico: a) problems in the basic identification and chronological placement of surficial archeological remains, and b) problems concerning the nature of Formative stage adaptations and the identification of archeological variability predicted by various models advanced by Hard (1983), Mauldin (1984), and Carmichael (1981, 1983, 1985), among others. It should be noted that adequate solutions to most, if not all, of these problems are dependent on data obtained from excavation and that the problems themselves are in many ways interrelated and interdependent.

**Problems of Chronology and Identification**

These problems involve serious ambiguities in the methods currently used to date archeological remains during survey efforts. One major area of concern centers on difficulties in distinguishing aceramic Formative stage lithic scatters from earlier Archaic period remains by using lithic assemblage characteristics as a basis for identification. This is especially problematical in the case of the small sites that are ubiquitous in central basin environs. Small lithic sites rarely contain diagnostic items, such as projectile points. Given the very active geomorphology in the basins of south-central New Mexico, it is misleading to assume that surface material, observed during any survey effort, represents or is representative of an entire site assemblage. Small Formative stage sites frequently contain minor amounts of brownware pottery to begin with and these artifacts are easily missed and/or hidden by shifting sands.

Recent attempts to solve these visibility problems have concentrated on the use of lithic assemblage characteristics to separate Archaic from aceramic Formative stage sites (Carmichael 1983; Chapman 1977; Chapman and Schutt 1977; Kerley and Hogan 1983). Although very few such studies have been conducted in south-central New Mexico, a number of analyses in the northern half of the state have demonstrated consistent differences in reduction trajectories and raw material diversity between Archaic and post-Archaic lithic assemblages. These results seem to show that Archaic assemblages can be characterized as reflecting a heavy emphasis on biface reduction strategies while post-Archaic remains are to a large extent oriented towards simple flake production (Chapman 1977; Chapman and Schutt 1977; Kerley and Hogan 1983). Other studies in the Hueco Bolson have suggested that a relatively high diversity in raw material types and in higher proportions of non-local materials may also be diagnostic of Archaic lithic assemblages (Carmichael 1983).

Analytical results from the Border Star 85 survey suggest that, in general, these patterns may be valid for the Southern Tularosa Basin, but there are presently too many other uncontrolled sources of variability to confidently use these assemblage signature methods as reliable chronological tools. Some of these sources include variability in site function (e.g., task-specific activities vs residential activities), occupational history (e.g., duration of occupation, number of consumers), or situational variables (such as distance from raw material sources).

Even when assemblages contain diagnostic artifact types, significant ambiguities continue to plague accurate chronological placement beyond a simple Preformative versus Formative stage division. In the case of projectile points (commonly the sole basis for dating lithic artifact sites) ambiguities arise in using typologies from adjacent regions, such as trans-Pecos Texas, the Oshara sequence of northern New Mexico, and the widespread Cochise tradition to the west. The Border Star 85 analysis revealed that several styles of projectile points found in the Jornada region have no counterparts in published typologies or represent somewhat extreme variants of existing types (O'Hara 1986). Although this analysis isolated several styles unique to the Tularosa Basin area and established similarities to the existing projectile point sequences, it was concluded that a regional typology based on firmly dated contextual information is sorely needed before these artifacts can be considered reliable chronological markers.

The situation for ceramic dating of sites is better, but there are significant inconsistencies in the use of this technique in the Jornada Mogollon region. Ceramic dating methods are based on simple presence/absence or co-occurrence criteria among a number of local and exotic pottery types. Aside from the fact that several key ceramic types are either poorly dated (e.g., El Paso Bichrome, El Paso Polychrome, Chupadero Black-on-White, and others) or are dated on the basis of non-local sequences (e.g., Mimbres Whitewares), the use of co-occurrence criteria is consistently insensitive to multiple components in large assemblages and, in the case of smaller assemblages, is subject to sampling problems involving temporally sensitive but rare ceramic types.

One of the Border Star 85 chronological analyses explored the analysis of El Paso Brownware vessel rim forms (Seaman and Mills 1986). Rim sherd analysis is based on patterned changes in vessel and rim form within local brownware ceramics (El Paso Brown and the painted variants) which have been recognized since the initial description of the Jornada Mogollon branch by Lehmer (1948). The quantitative basis for the technique is based on previous studies by West (1981) and Carmichael (1983; 1985) in which a rim sherd or rim thickness index (RSI) was developed and calibrated using a small number of dated ceramic assemblages. The advantages of this technique over the exclusive use of traditional typological methods are twofold. First, although brownware rim sherds cannot be considered ubiquitous in any ceramic assemblage in the Tularosa Basin/Hueco Bolson, they are far more common than most of the cross-dated trade wares used in the typologi-

cal method. El Paso brownwares dominate all ceramic assemblages in the Tularosa Basin area throughout the entire Formative stage. The use of this type is thus less subject to biases arising from small sample (i.e., assemblage) size and offers a means of distinguishing between Early Mesilla phase sites, which very rarely contain diagnostic ceramic types, and Late Mesilla phase remains. Second, rim sherd dating is quantitative and thus replicable. It may be possible to distinguish multiple temporal components in larger site assemblages by using intra-assemblage variability in RSI values. It is important to note that the technique is still in its infancy and is potentially subject to biases introduced by functional variability in vessel form among assemblages.

### Subsistence and Settlement

An important analytic effort of the Border Star 85 project centered on an exploration of Hard's (1983) adaptation model for the Late Mesilla phase. Rather than attempting to evaluate formally the validity of this model, the Border Star 85 effort was designed simply to recognize patterns of variability among the Border Star 85 Mesilla phase sites; that is, those patterns which were expectable on theoretical grounds but not explicitly stated in Hard's initial formulation. The model proposed by Hard (1983) is regional in scope and based on the premise that the subsistence and land-use strategies of Mesilla phase populations varied according to seasonal availability of critical resources. The model proposes that Mesilla phase adaptations relied primarily on wild food resources with a minor emphasis on food production. The argument is made that the basic organization of settlement and subsistence systems (cf. Binford 1980, 1982) will vary in response to seasonally patterned spatial and temporal incongruencies among plant products, animals, fuel sources, and water availability. When this regional model is applied to the environmental specifics of the Border Star 85 project area, the prediction is that sites will reflect spring and summer foraging organization with rates of residential mobility being conditioned chiefly by the availability of water. This result is based on the fact that, in the central basin, all critical resources except water are ubiquitous in their distribution.

Although not explicitly stated by Hard, one expectation of his model is that the long-term, cumulative results of this seasonal foraging pattern should be manifest in the relationships among site area, assemblage size, and assemblage diversity. This expectation is based on studies concerning the role of reoccupation in hunter-gatherer systems as an element of site formation processes by Vierra (1986) and on studies of inter-assemblage variability by Jones et al. (1983), Vierra and Doleman (1984), and Yellen (1977).

These latter studies indicate that a strong relationship among the variables of site area, assemblage size, and assemblage diversity is to be expected among forager site assemblages simply as a function of variations in use intensity (due to duration of occupation, number of consumers, and number of reoccupation events) characteristic of the formation of the sites. Although the cumulative archeological remains resulting from the operation of forager systems can be highly variable in size and assemblage diversity, the sites can be expected to be functionally identical in an organizational sense.

The Border Star 85 analysis focused on data pertaining to site size, assemblage size, and assemblage diversity from a small (n=11) sample of Formative stage sites, documented during a second intensive survey phase. Although the results were generally consistent with the above expectations, few statements could be made concerning the statistical significance of the findings or the utility of Hard's (1983) model, owing to the very small sample size. The Border Star 85 results are believed to be more significant when viewed in the context of previous research in the Tularosa Basin area. Settlement pattern studies by both Whalen (1977, 1978, 1980, 1981) and Carmichael (1981, 1983) have utilized variability in site area, assemblage size, and assemblage diversity in the formulation of functionally distinct site types (e.g., residential vs non-residential sites, camps vs villages). In other words, these typologies assume that variability in site size and complexity primarily reflects functional differences among sites. The Border Star 85 analysis results indicate both that this assumption may not be appropriate in the Hueco Bolson and southern Tularosa Basin and that the settlement patterns documented by both Whalen (1977, 1978, 1980, 1981) and Carmichael (1981, 1983) may have other explanations.

## Survey Methods

### GBFEL-TIE and Border Star 85 Data Comparability

The primary analytical goal of the GBFEL-TIE sample survey was the development of a predictive model which would allow for a comparison of the archeological remains within the three project alternatives, in terms of density, complexity, and ultimately, of significance of cultural resources. Because the development of the model relies in part on previously collected data, the issue of data comparability is a crucial aspect of the GBFEL-TIE project design. The Border Star 85 survey and data collection methods could not be simply emulated for the sample survey, however, owing to the fact that the aerial photo enlargements required by the Border Star 85 transect survey method could not be obtained prior to the GBFEL-TIE survey. Furthermore, a simple duplication of the Border Star 85 methods was not considered desirable because of the poor linkage between the Border Star 85 nonsite survey methods and the analytical goals of the project (documented by Seaman et al. 1986: Chapter 2).

The Border Star 85 survey involved two stages of fieldwork. The first phase, conducted prior to the Border Star 85 military exercises, consisted of a systematic survey of

225 km$^2$ within the southern Tularosa Basin. The GBFEL-TIE Orogrande Alternative is located entirely within this survey area. The purpose of the Phase I survey was to collect data appropriate for two goals: 1) locating maneuver and bivouac areas to minimize damage to archeological properties, and 2) choosing specific locales for investigation during the following intensive phase of survey. Phase I provided for the detailed recording of all cultural material and features falling within a predetermined grid system composed of 33.33 m long by 2 m wide transect recording units (TRUs), spaced 33.33 m apart and superimposed on 1:3000 scale aerial photo enlargements. Artifacts and features outside of TRU boundaries were noted, but with less detail. Conventional data pertaining to archeological sites were not recorded in the field. Site boundaries, however, were recorded on the aerial imagery. The definition of sites was dictated by the CE to be an analytical (rather than a data collection) task to be performed after the completion of Phase I survey, using the matrix of TRU data.

The abbreviated project schedule and the need for definition of site unit areas for compliance decisions, which were to be made almost immediately after the completion of Phase I survey, precluded analytical site definition. As a result, it was necessary to utilize the summarized TRU records for basic descriptive data on each of the 1809 sites discovered during Phase I.

These site specific data were considered inadequate by the New Mexico State Historic Preservation Officer in making National Register eligibility determinations. In response to this inadequacy, a strategy of complete site avoidance was adopted for the Border Star 85 maneuvers, in consultation with the New Mexico State Historic Preservation Officer. It must be emphasized that major tenets of the OCA proposal to the CE (in response to the Border Star 85 Solicitation) identified these deficiencies and proposed a number of alternative survey strategies which were not accepted by the CE.

The Phase II survey consisted of an intensive (100%) inventory of cultural remains using a 2 x 2 m grid superimposed on 1:750 scale aerial photo enlargements. Phase II focused on an extremely small sample (1.26 km$^2$ or 0.56%) of the total project area. The purpose of the Phase II effort was to provide data through which the major analytical goals of the project, including the definition of site areas, could be addressed. Based on the survey results, 39 sites were analytically defined within the six parcels. Only nine of these had been discovered previously during Phase I.

Doleman's (1986) analysis, comparing the results of each phase of survey, concluded that there was a general bias against discovery of small sites and toward discovery of larger properties. Phase I TRU survey consistently missed small archeological properties (largely due to the 33.33 m transect spacing) and, as a result, provided seriously misleading assemblage data. The comparative analyses conducted by Doleman indicate that, for the majority of the Border Star 85 "sites", these data should be considered unreliable as a basis for either cultural or temporal placement, or for functional interpretation. For larger (probably multicomponent) properties with numerically large samples of material culture, the TRU data also fail to provide information on the internal structure of these properties which would have allowed the isolation of individual components and, therefore, meaningful temporal and functional interpretations. Doleman's (1986) analysis did demonstrate, however, that at scales of resolution between 250–500 m, the Border Star 85 TRU methods (with some adjustments) provided reliable estimates for most kinds of cultural resources across the landscape. The results of this comparative analysis are further elaborated in Chapter 4.

The shortcomings of the Border Star 85 survey methods for providing site specific information (and the desire not to repeat them) were a major consideration in the design of the GBFEL-TIE sample survey project. The incomplete nature of the Border Star 85 data and the questions concerning reliability meant that the problem of site data comparability could not be truly solved; however, adjustments for the GBFEL-TIE sample survey project were made in the kinds of variables chosen for developing the predictive model and the spatial scale at which the analysis was performed. Corrections based on Doleman's calibration analysis (1986) were also applied to the Border Star 85 data to adjust for known biases in that data base.

### Units of Data Collection: Sites and Isolated Occurrences

The primary units of data collection utilized during the GBFEL-TIE sample survey consisted of archeological sites and the isolated occurrences. During the survey, the definition of sites and isolated occurrences remained flexible and relied heavily on the experience of the crew chiefs. Although the rushed project schedule was partially responsible for this situation, the overriding concern was the problem of archeological visibility. We approached archeological sites simply as discrete concentrations (relative to their immediate surroundings) of artifacts and/or cultural features which were expected to vary in their occupational histories. Isolated occurrences were defined simply as items which fell below the perceived threshold density of sites in any given area.

Archeological visibility is a problem that pervades virtually all survey in the basins of south-central New Mexico. The mesquite duneland vegetation community that dominates this area is believed to have spread throughout much of the American Southwest only during the last 100 years or so. Although an undulating landscape of mesquite coppice dunes has the appearance of stability, a 53-year longitudinal study conducted at the USDA Jornada Experimental Range has demonstrated that soil movement of considerable magnitude is common in this environment (Gibbens et al 1983). Archeological sites

are not easily delimited in mesquite coppice dunes. Some portions of the landscape exhibit widespread distributions of archeological debris, visible as lag materials in the blowouts between dunes. In such situations, it is difficult to determine whether discontinuities in the distribution of archeological material represent behavioral boundaries or are simply due to patterns of deflation and deposition.

It is also difficult to assess the integrity of archeological sites on the basis of surface survey; for example, intact fire-using features are rarely observed and architectural features are conspicuously absent on certain types of Formative stage sites, where they would otherwise be expected. Without subsurface investigations it is difficult to determine if the lack of intact features or architecture is due to past human behavior, to visibility factors, or to poor site integrity.

A large proportion of sites also appears to contain temporally ambiguous or multicomponent assemblages. When confronted with archeological materials of different ages in interdune blowouts, it is difficult to discern if associations are a function of the deflation of stratigraphically separated assemblages present in stabilized dunes, of a horizontal overlap of temporally distinct occupations also present in adjacent coppice dunes, or of an extended occupation of the same site. However, present ambiguities in non-chronometric dating methods also complicate matters considerably.

We believe that these problems have no adequate solutions in the context of this archeological survey. As Whalen (1985) has demonstrated at the nearby Bruton Bead Site, a far more intensive effort is necessary to simply define site boundaries and assess the temporal placement of the site. Whalen's strategy involves the accurate mapping of surface artifact distributions and vegetation patterns on scaled aerial photos and the use of systematic soil coring for subsurface investigations. To be sure, the Bruton Bead Site lies on the extreme end of the scale when it comes to size and complexity, but it is certainly not unique. Given these problems, the sites defined during the GBFEL–TIE sample survey and reported here should be seen only as first approximations or temporary constructs, subject to modification by more intensive investigations.

### Sampling and Discovery Procedures

The basic unit of organization for both field survey and data management was the survey unit (SU). In accordance with the scope of work, these units were 500 x 500 m in size and were registered within the UTM grid (Zone 12). Survey units were identified using a sequential series of numbers assigned prior to survey.

Survey units were chosen using a stratified random design. In an effort to ensure reasonably even coverage, arbitrary spatial units were used as stratification criteria. Each proposed facility alternative was divided into a series of 2 x 2 km units, from which two survey units (out of a total of 16) were chosen in each strata using random numbers generated by a hand–held calculator. Due to the uneven shape and skewed orientation of the Stallion and NASA areas with reference to the UTM grid, using the 2 x 2 km strata to encompass the alternatives resulted in fully defining an area somewhat larger than the GBFEL–TIE alternative boundaries themselves. Because many of the initially chosen survey units fell partially outside the survey area boundaries, a convention was adopted that discarded such survey units if over 50% of their area fell outside the survey area boundary.

A total of 26 survey units were chosen in each alternative, using this strategy. Since 31 total units were required in each area, in order to approximate the sampling target of 1920 acres, 5 additional units were chosen on a subjective basis. These discretionary survey units were surveyed after completion of the 26 randomly chosen units and were used to fill in the gaps left by the initial pattern. The approximate sampling fractions are listed in Table 2.1.

Table 2.1. GBFEL-TIE survey area statistics

| Alternative | Area ($km^2$) Total | Area ($km^2$) Sample | Sample Percent |
|---|---|---|---|
| Stallion | 54 | 7.75 | 14.35 |
| NASA | 56 | 7.75 | 13.84 |

It should be emphasized that the Scope of Work dictated a target sample of 1920 acres (7.75 $km^2$) per alternative. Armed only with 1:10,000 and 1:24,000 topographic maps during survey, it was difficult to locate the boundaries of many of the survey units. In some areas with minimal or very gradual topographic relief, it was necessary to approximate the specified locations through compass triangulations, pacing, and off–road odometer readings. In most cases, the level of accuracy is within ± 50–100 m. In order to facilitate relocation, one corner of each unit was marked with a wooden stake (2 x 2 in), identifying the survey unit number and the cardinal direction of the corner (e.g., NE, SW, etc.). The marked survey unit corner varied and the stake was typically set with 10-20 cm visible above the ground.

Each survey unit was surveyed by a single crew of five archeologists spaced 25 m apart. Survey transects began at one corner of the survey unit and proceeded systematically until completion. During survey, all isolated artifacts within 2.5 m of each transect line were documented with locational control to 250 x 250 m quadrants within the survey unit (e.g., NW, SE, etc.). Site discovery and recording procedures varied with the density, extent, and complexity of the artifact distributions encountered. Small, easily delimited properties were recorded and their contents analyzed as they were discovered during survey.

Larger, more complex sites were frequently defined with several stages of survey. In these cases, the basic strategy was to continue transect survey of the survey unit, marking perceived boundaries clearly with each pass through the site. Once a large site was delimited in this fashion, it was resurveyed more intensively and recording/analysis efforts completed. Where very large, diffuse sites were intersected by survey unit boundaries, complete definition was not possible. The perimeters of all other sites were completely defined.

Coordinate locations of sites were determined in one of two ways. Whenever possible, Silva compass or Brunton azimuth readings from at least two known points were used to locate sites (and survey units) accurately on topographic maps. In areas with inadequate topographic relief or other orienting features, sites were located with reference to the survey unit boundaries on 1:10,000 scale topographic maps. As noted previously, survey unit locations were frequently approximate, so site locations in such cases can only be considered as accurate as those of the survey unit. In all cases, site datums were marked using wooden stakes (2 x 2 in) with permanent aluminum tags identifying the site.

### Recording and Analysis Procedures

After discovery, site recording procedures began with a systematic inspection of the site area for the purpose of boundary definition and the identification of various site features (e.g., artifact concentrations, hearths, or architectural features). On most sites, pin flags were used during initial inspections to mark different kinds of features for mapping and as an estimate of overall artifact density. However, there was no attempt to mark all artifacts on extensive and/or dense properties. In such cases, a consistent proportion of the total number (such as every fifth or tenth) artifact was marked; the actual proportion used depended on overall density and site size. During this activity, all chronologically sensitive or otherwise rare artifacts were marked for later recording and/or collection.

When appropriate, more complex sites were divided into two or more proveniences (as a data recording convention, all sites contained at least one provenience). Proveniences were defined as distinct internal units of a site determined on the basis of variations in the spatial distribution of artifacts and features. These spatial units were identified subjectively by the crew chiefs in an effort to monitor internal variability in site content and to detect multiple components. An attempt was made to define all proveniences within sites, but when exceptionally high densities were encountered in the NASA Alternative, this strategy had to be abandoned.

Recording of each site consisted of three major tasks: 1) site mapping, 2) completing a Master Site Form (MSF), and 3) performing artifact sample analyses and collections.

**Site mapping.** A scaled sketch map was prepared for each sampled provenience which illustrates boundaries, the locations of features and sample locations in relation to the site datum stake, local topographic/vegetative features, and drainage/relief patterns. Scaled maps of entire sites were produced only for smaller properties. Intermediate-sized and large sites were plotted as accurately as possible on 1:10,000 and 7.5′ topographic maps.

**Master Site Form.** The Master Site Form (MSF) (Appendix 2), contains clerical data (such as date and recorder name), coded information, and narrative information. Coded information is organized into two basic sections on the MSF and one section is used for narrative information.

1) *Site specific information* (location, setting, condition, and temporal placement):

- Survey unit (SU) number (sequential for entire survey)
- Field site number (sequential for entire survey; permanent Laboratory of Anthropology site numbers were assigned by ARMS personnel)
- UTM coordinates and elevation (at site center, computed after survey from topographic map locations)
- Site dimensions (length and width in meters) from field measurements
- Ecological Zone, Topography, and Condition (ARMS codes)
- Cultural/Temporal components represented

2) *Provenience specific information*:

- Provenience number (sequential within site)
- Feature types present and count (such as midden, hearth, or scatter; keyed to site map)
- Estimated fire cracked rock/burned caliche count (0–10, 11–30, 31–100, >100)
- Suspected maximum depth in meters
- Provenience dimensions in meters
- Sample information (see below)

3) *Narrative information* was also recorded on the MSF mainly to justify and clarify the coded information. Five categories of narrative data were recorded:

- General site description: basic description of site proveniences and features; general impressions
- Location and access data: brief narrative description of local vegetative and topographic setting, access routes, local, natural or man-made features to aid in relocation

•Temporal/Cultural components: specification of criteria used in making temporal/cultural assignments for site and proveniences

•Boundaries: justification and description of site/provenience boundaries

•Site condition/preservation: discussion of site/provenience condition; justification of maximum depth estimates

**Artifact collections and sampling.** Collections on sites were limited to artifacts believed to be chronologically sensitive but that would require further analysis for identification. Identifiable projectile points were systematically collected from all sites for laboratory analysis.

All sampling was performed at the provenience level. A flexible sampling method was utilized to gain several kinds of information concerning site chronology, function, and assemblage diversity/size. Any one or any combination of three types of samples were made at the discretion of the crew chief and included flag samples, diagnostic or rare item samples, and discrete samples. Specific sample types and their size were coded on the Master Site Form. The locations of discrete samples were keyed to site/provenience sketch maps.

The most frequently used sampling method was the flag sample. This method focused on artifacts marked during site definition with pin flags and was designed to collect information on site function and assemblage size. While all surface artifacts were marked and analyzed on smaller sites, it was necessary to sample larger or more dense properties. On larger sites, crew chiefs attempted to obtain a representative sample of artifacts within the boundaries of each provenience by using flagged artifacts as a guide. For every artifact analyzed, the nearest unmarked artifact was also chosen for analysis in order to control for the likelihood that only the largest artifacts would have been noticed during initial site definition. The numerical size of these samples depended on gross estimates of total assemblage size for the provenience being sampled, but an arbitrary minimum of 20 artifacts were analyzed from each provenience.

Diagnostic or rare samples focused on all chronologically sensitive or functionally specific artifacts flagged during initial site definition. This sample type is believed to provide reliable estimates of assemblage diversity or variety and forms a basis for chronological placement. When rare samples were utilized, an attempt was made to record the full range of variability in ceramics and lithic tools observed across the site or provenience.

Area or discrete samples (e.g., transects, quadrants, or circles) were utilized, when maximum density estimates were deemed necessary, for descriptive purposes and to complement rare samples with detailed debitage information. Circular or tethered samples were the most common type of sample taken. Discrete samples were usually placed in areas of high artifact density and were proportionally sized to yield a minimum of 20 artifacts.

A single Artifact Sample Form (ASF) (Appendix 2) was utilized for all artifact samples. All attribute and frequency variables relevant to ceramic, lithic, and historic artifacts were coded on this form along with site, provenience, feature, and sample identifiers. Attribute definitions, codes, and analysis conventions are essentially identical to (or extensions of) those utilized during the Border Star 85 Phase II survey effort (Seaman et al. 1986). Recorded variables are briefly summarized below and are listed in detail in Appendix 2.

Lithic and ground stone artifacts:

- Artifact type (such as flake, scraper, metate)
- Material type (such as chert, sandstone, obsidian)
- Condition (such as complete, proximal, distal)
- Length, thickness, dorsal cortex %, platform type (complete flakes only)

Ceramic artifacts:

- Pottery type (such as El Paso Brown, Mimbres Black-on-White)
- Sherd frequency

## Survey Coverage Rates

Survey coverage rates varied considerably between the Stallion and NASA Alternatives. As will be discussed in Chapters 3 and 4, the number, size and complexity of archeological sites were far greater in the NASA Alternative. This fact is reflected in the effort required to survey the same number of survey units in the two areas (Table 2.2).

Table 2.2. GBFEL-TIE survey rates of coverage

| Alternative | Effort[1] | Survey Area[2] | Survey Rate[3] |
|---|---|---|---|
| Stallion | 63.5 | 1915 | 30.16 |
| NASA | 144.5 | 1915 | 13.25 |
| Both Alternatives | 208.0 | 3830 | 18.41 |

1 =person days; 2=acres; 3=acres/person day

The NASA rate is less than half that of the Stallion survey rate. Even when differences in daily travel time are taken into account (ca. 19% of survey effort for NASA; negligible for Stallion), the NASA survey rate increases only 3.12 acres/person day. It should be realized that

several minor adjustments were made to site sampling methods in order to cope with the remarkably high site density in the NASA area. These survey rates may seem low, but are considered realistic, given the nature of the archeology and the environment in the two alternatives. Without aerial imagery, it is doubtful that these rates could be significantly improved.

Chapter 3

# SURVEY RESULTS

The following discussion of archeological sites recorded during the GBFEL–TIE survey (Stallion and NASA Alternatives) is based on site summary data presented in Appendix 2. Individual descriptions of the 724 sites from the Orogrande Alternative, recorded during the previous Border Star 85 project, are provided in Seaman, et al. (1986) and are treated only in summary fashion in this report.

## The Stallion Alternative

Thirty archeological sites were recorded during survey of the 31 sample units in the Stallion Alternative. These sites are summarized by chronological period in Tables 3.1 and 3.2. Over 50% of these sites contain Preformative stage components. Although no single-component, Paleoindian sites were discovered in the sample area, materials diagnostic of this period were found on three Multicomponent sites with additional Archaic and, in two of the three cases, Formative stage materials. No Clovis artifacts were identified, but two Folsom projectile point bases indicate Paleoindian use of this area between ca. 9500–10,500 BP. Other Paleoindian artifacts recorded in the Stallion Alternative include a considerable number of small, well-made beaked scrapers, which may be suggestive of the Paleoindian period (Elyea 1986; Rogers 1986).

Eight sites (26.7%) were judged to date to the Archaic period, based on diagnostic projectile point styles and observations of debitage characteristics indicative of bi–

Table 3.1. Summary of survey results: Stallion Alternative (site structure)

| Period | Statistic | Estimated Site Area ($m^2$) | Mean Artifact Density (per $m^2$) | Mean FCR Density (per $m^2$) | Est. Max Depth (cm) | No. Hearths | No. Arch. Features |
|---|---|---|---|---|---|---|---|
| | mean | 8578 | 0.077 | 0.020 | 61 | 0.0 | 0.0 |
| Archaic | std. dev. | 17588 | 0.028 | 0.022 | 27 | - | - |
| (n=7; 23.3%) | median | 743 | 0.084 | 0.010 | 50 | - | - |
| | minimum | 78 | 0.026 | 0.001 | 30 | - | - |
| | maximum | 48106 | 0.103 | 0.064 | 100 | - | - |
| | mean | 2555 | 0.041 | 0.011 | 26 | 0.0 | 0.0 |
| Lithic Unknown | std. dev. | 5814 | 0.041 | 0.017 | 24 | - | - |
| (n=12; 40%) | median | 646 | 0.023 | 0.005 | 22 | - | - |
| | minimum | 113 | 0.002 | 0.000 | 0 | - | - |
| | maximum | 20892 | 0.133 | 0.051 | 75 | - | - |
| | mean | 15394 | 0.005 | 0.111 | 70 | 0.0 | 0.0 |
| Multicomponent | std. dev. | - | - | - | - | - | - |
| (Formative) | median | - | - | - | - | - | - |
| (n=1; 3.3%) | minimum | - | - | - | - | - | - |
| | maximum | - | - | - | - | - | - |
| | mean | 6671 | 0.050 | 0.008 | 56 | 0.1 | 0.0 |
| Multicomponent | std. dev. | 6332 | 0.053 | 0.015 | 44 | 0.3 | - |
| (Pre/Form) | median | 4555 | 0.043 | 0.003 | 50 | 0.0 | - |
| (n=9; 30.0%) | minimum | 424 | 0.007 | 0.000 | 0 | 0.0 | - |
| | maximum | 20452 | 0.173 | 0.047 | 100 | 1.0 | - |

Table 3.2. Summary of survey results: Stallion Alternative (site content)

| Period | Statistic | #Lith types | #Cerm types | #Matl types | %Cores | %Pndg tools | %Infml tools | %Frml tools | %Grdg tools |
|---|---|---|---|---|---|---|---|---|---|
| | mean | 8.3 | 0.0 | 8.1 | 7.0 | 3.3 | 13.4 | 32.6 | 43.9 |
| Archaic | std. dev. | 4.9 | - | 3.6 | 9.7 | 4.3 | 17.6 | 26.1 | 36.1 |
| (n=7; 23.3%) | median | 7.0 | - | 8.0 | 0.0 | 0.0 | 0.0 | 30.0 | 53.0 |
| | minimum | 4.0 | - | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | maximum | 18.0 | - | 14.0 | 21.0 | 10.0 | 40.0 | 67.0 | 100.0 |
| | mean | 5.8 | 0.0 | 5.8 | 30.5 | 1.5 | 9.8 | 4.4 | 53.9 |
| Lithic Unknown | std. dev. | 2.3 | - | 1.5 | 37.4 | 5.1 | 16.6 | 6.7 | 39.5 |
| (n=12; 40%) | median | 6.5 | - | 6.0 | 17.0 | 0.0 | 0.0 | 0.0 | 70.0 |
| | minimum | 3.0 | - | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | maximum | 10.0 | - | 8.0 | 100.0 | 17.0 | 50.0 | 20.0 | 100.0 |
| | mean | 8.0 | 2.0 | 7.0 | 0.0 | 0.0 | 29.0 | 29.0 | 43.0 |
| Multicomponent | std. dev. | - | - | - | - | - | - | - | - |
| (Formative) | median | - | - | - | - | - | - | - | - |
| (n=1; 3.3%) | minimum | - | - | - | - | - | - | - | - |
| | maximum | - | - | - | - | - | - | - | - |
| | mean | 9.7 | 1.4 | 8.6 | 7.3 | 1.0 | 27.7 | 34.7 | 29.3 |
| Multicomponent | std. dev. | 3.7 | 0.7 | 1.4 | 8.3 | 2.0 | 25.6 | 15.8 | 19.9 |
| (Pre/Form) | median | 10.0 | 1.0 | 8.0 | 4.0 | 0.0 | 17.0 | 33.0 | 33.0 |
| (n=9; 30.0%) | minimum | 5.0 | 1.0 | 7.0 | 0.0 | 0.0 | 0.0 | 15.0 | 0.0 |
| | maximum | 16.0 | 3.0 | 12.0 | 20.0 | 5.0 | 67.0 | 60.0 | 62.0 |

Key

| | |
|---|---|
| #Lith types | number of lithic artifact types |
| #Cerm types | number of ceramic types |
| #Matl types | number of lithic material types |
| %Cores | percent of cores in assemblage |
| %Pndg tools | percent of pounding implements (e.g., hammerstones, mauls) in assemblage |
| %Infml tools | percent of informal tools (e.g., retouched flake tools) in assemblage |
| %Frml tools | percent of formal tools (e.g., scrapers, knives) in assemblage |
| %Grdg tools | percent of grinding implements (e.g., manos, metates) in assemblage |

(See Appendix 2 for descriptions of artifact types, lithic material types, etc.)

face reduction strategies. Unfortunately, neither identification criteria can presently provide precise or reliable estimates of age within the ca. 7500-year long Archaic period in south-central New Mexico (Seaman et al. 1986). The range of variability evident in the projectile point forms does suggest that the entire Archaic period is represented and that elements of the Cochise, Oshara, and trans-Pecos Texas typologies are present.

Archaic sites recorded in the Stallion Alternative range in size from 78–48,106 $m^2$, with a mean of 8578 $m^2$ (Table 3.1). This latter statistic is heavily influenced by a single large site, since the median size for Archaic sites is only 743 $m^2$. Estimates of surface artifact density for this group average 0.077 items/$m^2$ with a median density of 0.084 items/$m^2$. No intact hearths or other fire-using features were observed, however, fire-cracked rock concentrations were recorded on all sites. These latter are presumed to represent the disintegrated remains of such features. Overall, fire-cracked rock densities between 0.001 and 0.064 fragments/$m^2$ were computed for Archaic sites (mean=0.02 $m^2$; median=0.01 $m^2$) on the basis of field observations.

Artifact assemblages for the Stallion Archaic sites are dominated by lithic debitage with minor proportions of formal and informal lithic tools. A minimum of four lithic material types and a maximum of 14 types (mean=8.1) are present at these sites along with an average of 8.3 lithic artifact classes per site (Table 3.2). Fragmentary groundstone implements are common in almost all of the Archaic sites with a mean proportion of 43.9% within the tool assemblages. Formal flaked stone tools such as bifaces, scrapers, and projectile points are also common

and constitute an average of 32.6% of tool assemblages. Informal lithic tools, such as retouched flakes, cores, and hammerstones regularly occur within Archaic tool assemblages in the Stallion sample—typically at proportions less than 10%.

Although Paleoindian and/or Archaic components are present within an additional nine sites (30%) in the Stallion sample, these sites additionally contained Formative stage ceramics thus making temporal assignments even more ambiguous. Ceramics represent extremely small proportions of these assemblages and, in a majority of cases, consist of poorly dated types, (e.g., Unspecific Brown and Jornada Brown). Pottery type variety is also extremely low with a maximum of three pottery types and a mean of 1.4 types per site.

Although the average size (mean=6671 $m^2$ per site) of Multicomponent sites is well below that for single component Archaic sites, there is significantly less variability in size, as can be seen in a comparison of median, rather than mean (Table 3.1). Overall artifact density figures for Multicomponent sites are also lower on the average, but are more variable, as seen in the minimum and maximum figures (Table 3.1).

Given the extremely large area and continuous, low artifact density of most Multicomponent sites, it was not possible to segregate the Paleoindian, Archaic, or Formative components at the provenience level on the basis of field observations. Consequently, assemblage data from this group of sites must be viewed as representing a composite sample of archeological remains, generated over an extremely long period of time.

A single, late Formative stage site was discovered in the Stallion Alternative. This relatively large scatter of lithic artifacts and fire–cracked rock is believed to date to the Doña Ana and/or El Paso phases on the basis of scant ceramic evidence. A small homestead or ranch line–camp was also discovered and appears to date to the late 1920s or early 1930s, based on surface trash.

Finally, 12 archeological sites (40%) which could not be assigned to any chronological period were recorded in the Stallion Alternative. These aceramic sites contain a small number of nondiagnostic lithic tools and cannot be placed even into gross temporal categories. When compared to other sites in the Stallion sample that can be placed chronologically, Lithic Unknown sites are typically much smaller in areal extent, have lower artifact densities, and have numerically smaller and less diverse assemblages. This situation should not be surprising as most chronologically sensitive artifacts are rare, usually constituting an extremely small assemblage proportion; thus the potential for dating would be expected to decrease with assemblage size, other things being equal.

## The NASA Alternative

Fifty–one archeological sites were recorded during survey of the 31 survey units in the NASA sample; the sites are summarized by major chronological period (Tables 3.3 and 3.4). No evidence was found of Paleoindian use of the NASA area, although this situation may be due to post–Pleistocene aggradation on the alluvial fan. Eight sites (15.7%) appear to date to the Archaic period and three additional Lithic Unknown sites (5.8%) may also be Archaic.

Archaic sites range in size from 127 $m^2$ to 31,416 $m^2$ (mean=6236 $m^2$), and have artifact densities between 0.04 and 0.36 artifacts/$m^2$ (mean=0.11 $m^2$). Suspected maximum depth figures range from 10 cm to 60 cm (mean=41 cm) but, given the very active dunes covering almost all of the NASA Alternative, these figures are highly speculative.

The NASA Archaic sites typically contain one or more concentrations of fire–cracked rock, and on occasion, apparently intact hearths or roasting pits. Fire–cracked rock density was high on most of these sites with a mean of 0.133 fragments/$m^2$. Lithic debitage and tools dominate Archaic artifact assemblages and commonly exhibit a pronounced emphasis on biface tool manufacture and maintenance. Typically, almost half of the Archaic tool assemblages consist of broken grinding implements, followed by equal proportions (ca. 20%) of formal and informal tools. Between four and eight different lithic materials are present as either tools or debitage, and an average of nine distinct tool types are present in the average NASA Archaic assemblage.

In addition to these single component Archaic sites, 14 (28%) Multicomponent sites, with evidence of both Formative and Preformative occupation, were recorded in the NASA Alternative. As a group, the sites are quite extensive with an average area of 98,802 $m^2$ and a maximum of 486,461 $m^2$. Half of these sites were found to extend beyond survey unit boundaries, although these statistics are based on incomplete information. It should also be noted that the perceived boundaries for these and most other sites documented in the NASA Alternative may be just as much a function of modern geomorphological factors as past behavioral ones.

Counting these 14 Multicomponent sites, over 78% (40 sites) of the NASA sites have Formative stage components. Twenty–six (51%) sites contain Formative materials that date, on the basis of ceramic assemblages, to the Mesilla phase (4 sites or 16.7%), the El Paso phase (8 sites or 33.3%), or combinations thereof (14 sites or 58.3%). The latter sites may represent Doña Ana phase manifestations however, it should be recognized that the associations of specific ceramic types may be spurious, due to the effects of geomorphological processes. The meanings assigned to such associations, therefore may be questioned and it is possible that many of these Doña

Table 3.3. Summary of survey results: NASA Alternative (site structure)

| Period | Statistic | Estimated Site Area ($m^2$) | Mean Artifact Density (per $m^2$) | Mean FCR Density (per $m^2$) | Est. Max Depth (cm) | No. Hearths | No. Arch. Features |
|---|---|---|---|---|---|---|---|
| | mean | 6236 | 0.110 | 0.133 | 41 | 0.2 | 0.0 |
| Archaic | std. dev. | 10822 | 0.111 | 0.279 | 16 | 0.7 | - |
| (n=8; 15.7%) | median | 1604 | 0.057 | 0.025 | 50 | 0.0 | - |
| | minimum | 127 | 0.039 | 0.000 | 10 | 0.0 | - |
| | maximum | 31416 | 0.363 | 0.810 | 60 | 2.0 | - |
| | mean | 899 | 0.064 | 0.015 | 33 | 0.0 | 0.0 |
| Lithic Unknown | std. dev. | 682 | 0.063 | 0.023 | 15 | - | - |
| (n=3; 5.9%) | median | 1206 | 0.036 | 0.004 | 30 | - | - |
| | minimum | 118 | 0.020 | 0.000 | 20 | - | - |
| | maximum | 1374 | 0.136 | 0.042 | 50 | - | - |
| | mean | 5033 | 0.311 | 0.044 | 45 | 0.8 | 0.8 |
| Mesilla Phase | std. dev. | 8022 | 0.465 | 0.039 | 17 | 1.0 | 1.5 |
| (n=4; 7.8%) | median | 1466 | 0.055 | 0.046 | 50 | 0.5 | 0.0 |
| | minimum | 236 | 0.030 | 0.000 | 20 | 0.0 | 0.0 |
| | maximum | 16965 | 0.847 | 0.085 | 60 | 2.0 | 3.0 |
| | mean | 43096 | 0.150 | 0.046 | 54 | 0.0 | 0.0 |
| El Paso Phase | std. dev. | 109591 | 0.278 | 0.067 | 34 | - | - |
| (n=8; 15.7%) | median | 4689 | 0.045 | 0.020 | 50 | - | - |
| | minimum | 25 | 0.013 | 0.002 | 10 | - | - |
| | maximum | 314160 | 0.716 | 0.199 | 100 | - | - |
| | mean | 45797 | 0.127 | 0.139 | 59 | 1.6 | 0.4 |
| Multicomponent | std. dev. | 65758 | 0.059 | 0.271 | 32 | 2.0 | 0.9 |
| (Formative) | median | 9032 | 0.136 | 0.060 | 60 | 1.0 | 0.0 |
| (n=14; 27.5%) | minimum | 118 | 0.049 | 0.003 | 10 | 0.0 | 0.0 |
| | maximum | 192423 | 0.187 | 1.050 | 100 | 6.0 | 3.0 |
| | mean | 92802 | 0.074 | 0.098 | 63 | 1.4 | 0.2 |
| Multicomponent | std. dev. | 153781 | 0.045 | 0.185 | 43 | 2.2 | 0.8 |
| (Pre/Form) | median | 18064 | 0.057 | 0.032 | 55 | 1.0 | 0.0 |
| (n=14; 27.5%) | minimum | 314 | 0.035 | 0.000 | 20 | 0.0 | 0.0 |
| | maximum | 486461 | 0.175 | 0.700 | 150 | 8.0 | 3.0 |

Ana phase sites represent reoccupation of Late Mesilla sites during the El Paso phase. Within this group, Mimbres whitewares are most commonly associated with El Paso types such as Playas Red, Chupadero Black-on-White, El Paso Polychrome, and other trade wares (9 sites or 64.3%), but also with earlier Mesilla wares such as San Francisco Red, Socorro Black-on-White, Mogollon Red-on-Brown, and El Paso Plain Brown (3 sites or 21.4%). Two of these Multicomponent sites also contain the full range of Formative ceramics. Until the dating and areas of manufacture for the Mimbres whitewares are firmly established for regions outside of the Mimbres Valley, there will continue to be confusion in the identification of the Doña Ana phase, as defined by current conventions (Rugge 1986).

Many Formative stage sites in the NASA Alternative are quite extensive and the boundaries of only half were completely defined during survey. One site which was not completely defined encompasses an entire survey unit and half of an adjacent survey unit. Based on an inspection of extant bladed trails, this same site area appears to continue within an elevational zone along the alluvial fan for at least 4 km across and to the south of the NASA area. However, visibility and boundary definition problems must, again, be taken into consideration. This site cannot be treated as a single site but is, perhaps, best thought of as a continuous site *area* containing a large number of components, which are a function of reoccupation rather than aggregation.

Table 3.4. Summary of survey results: NASA Alternative (site content)

| Period | Statistic | #Lith types | #Cerm types | #Matl types | %Cores | %Pndg tools | %Infml tools | %Frml tools | %Grdg tools |
|---|---|---|---|---|---|---|---|---|---|
| | mean | 9.1 | 0.0 | 6.0 | 13.6 | 1.9 | 20.8 | 20.4 | 43.5 |
| Archaic | std. dev. | 2.9 | - | 1.5 | 12.1 | 3.7 | 18.2 | 19.0 | 27.7 |
| (n=8; 15.7%) | median | 9.0 | - | 5.5 | 13.0 | 0.0 | 18.5 | 22.0 | 50.0 |
| | minimum | 5.0 | - | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.0 |
| | maximum | 14.0 | - | 8.0 | 33.0 | 10.0 | 50.0 | 50.0 | 88.0 |
| | mean | 7.0 | 0.0 | 3.3 | 16.7 | 0.0 | 8.3 | 4.3 | 71.0 |
| Lithic Unknown | std. dev. | 2.7 | - | 0.6 | 16.5 | - | 14.4 | 7.5 | 10.6 |
| (n=3; 5.9%) | median | 6.0 | - | 3.0 | 17.0 | - | 0.0 | 0.0 | 67.0 |
| | minimum | 5.0 | - | 3.0 | 0.0 | - | 0.0 | 0.0 | 63.0 |
| | maximum | 10.0 | - | 4.0 | 33.0 | - | 25.0 | 13.0 | 83.0 |
| | mean | 7.5 | 4.8 | 5.5 | 40.3 | 0.0 | 8.0 | 13.3 | 38.2 |
| Mesilla Phase | std. dev. | 4.2 | 5.6 | 1.9 | 21.5 | - | 11.8 | 16.2 | 18.6 |
| (n=4; 7.8%) | median | 7.5 | 2.5 | 5.0 | 50.0 | - | 3.5 | 10.0 | 37.5 |
| | minimum | 3.0 | 1.0 | 4.0 | 8.0 | - | 0.0 | 0.0 | 20.0 |
| | maximum | 0.2 | 13.0 | 8.0 | 53.0 | - | 25.0 | 33.0 | 58.0 |
| | mean | 6.4 | 4.5 | 5.5 | 25.5 | 0.8 | 6.2 | 22.2 | 45.5 |
| El Paso Phase | std. dev. | 4.0 | 2.5 | 2.0 | 16.3 | 2.0 | 10.1 | 20.8 | 22.0 |
| (n=8; 15.7%) | median | 5.5 | 5.0 | 5.5 | 24.5 | 0.0 | 2.5 | 20.5 | 41.0 |
| | minimum | 1.0 | 1.0 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 | 24.0 |
| | maximum | 12.0 | 8.0 | 9.0 | 50.0 | 5.0 | 26.0 | 48.0 | 75.0 |
| | mean | 9.0 | 9.1 | 5.9 | 24.6 | 4.1 | 16.6 | 21.8 | 32.6 |
| Multicomponent | std. dev. | 4.4 | 6.4 | 3.0 | 20.9 | 8.2 | 16.0 | 26.6 | 23.3 |
| (Formative) | median | 9.5 | 9.0 | 5.5 | 21.0 | 0.0 | 15.0 | 11.5 | 35.5 |
| (n=14; 27.5%) | minimum | 1.0 | 1.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | maximum | 16.0 | 22.0 | 12.0 | 75.0 | 25.0 | 56.0 | 100.0 | 83.0 |
| | mean | 10.4 | 7.7 | 6.3 | 18.4 | 0.8 | 20.7 | 22.9 | 37.3 |
| Multicomponent | std. dev. | 4.0 | 7.1 | 1.7 | 14.2 | 1.7 | 16.3 | 14.1 | 20.9 |
| (Pre/Form) | median | 10.5 | 6.0 | 6.0 | 19.5 | 0.0 | 13.5 | 24.0 | 40.0 |
| (n=14; 27.5%) | minimum | 5.0 | 1.0 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | maximum | 18.0 | 24.0 | 10.0 | 46.0 | 5.0 | 50.0 | 50.0 | 73.0 |

Key

| | |
|---|---|
| #Lith types | number of lithic artifact types |
| #Cerm types | number of ceramic types |
| #Matl types | number of lithic material types |
| %Cores | percent of cores in assemblage |
| %Pndg tools | percent of pounding implements (e.g., hammerstones, mauls) in assemblage |
| %Infml tools | percent of informal tools (e.g., retouched flake tools) in assemblage |
| %Frml tools | percent of formal tools (e.g., scrapers, knives) in assemblage |
| %Grdg tools | percent of grinding implements (e.g., manos, metates) in assemblage |

(See Appendix 2 for descriptions of artifact types, lithic material types, etc.)

The mean site area for the eight El Paso phase sites is 43,096 m$^2$, with a median size of 4689 m$^2$. The mean size for Formative Multicomponent sites is very close to the El Paso phase figure at 45,797 m$^2$, but the median size is almost twice as large at 9032 m$^2$. Mesilla phase sites are much smaller in size with a mean of 5033 m$^2$ and a median of 1466 m$^2$.

Formative stage sites typically contain widely dispersed scatters of ceramics, lithic debitage, lithic tools, and fire-cracked rock. These sites vary in mean artifact density

from 0.127 (Multicomponent) to 0.311 artifacts/$m^2$ (Mesilla phase). Maximum densities range as high as 27.60 artifacts/$m^2$ (Multicomponent). Fire-cracked rock density ranges from 0.044 (Mesilla) to 0.139 (Multicomponent) fragments/$m^2$. Most Formative stage sites also contain one or more hearths. Although architectural features such as adobe walls or pit structures were not recognized (probably due to the active surface geology), it is almost certain that such features exist subsurface on many of the denser sites.

Formative stage assemblages consist of ceramics, lithic reduction debris, and a variety of stone tools. A wide range of local and traded ceramics dominate most of the Doña Ana and El Paso phase assemblages, while Mesilla phase sites rarely contain large amounts of pottery. Also, ceramic type diversity is lower for a majority of Mesilla phase sites, as most of the pottery is Plain Brown body sherds. On some of the larger late Formative sites, the diversity of ceramic types present is extreme. In all cases, the predominant local ceramic types are El Paso brownwares (mainly El Paso Polychrome), accompanied by Chupadero Black-on-White, Mimbres Classic Black-on-White, Playas Red, and a variety of other trade wares such as Mexican polychromes, Rio Grande and Zuni glazewares, White Mountain redwares, and Gila Polychrome.

Formative lithic tool assemblages are also diverse. Average tool variety ranges from 6.4 types (El Paso phase) to 9.0 types (Multicomponent) for the NASA Formative sites. Formal tools such as scrapers, projectile points, and other bifacial implements commonly make up 10–20% of lithic tool assemblages. Informal flake tools make up 10% or less of these tool assemblages. Fragmentary groundstone tools, such as one-hand and two-hand manos, slab and basin metates, and schist pestles consistently make up 30–40% of lithic tool assemblages. Pounding implements, such as mauls and hammerstones, make up about 25% of Formative tool assemblages. Lithic material variability is also high in the Formative assemblages, with an average of six generic types represented.

## The Orogrande Alternative

An area slightly larger than the specified size of the Orogrande Alternative was used as a basis for extracting site data from the Border Star 85 data base (Seaman et al. 1986). A total of 724 archeological sites were recorded during the Border Star 85 survey within this area. The majority of these sites (426 or 58.8%) were classified as Lithic Unknown on the basis of analyzed artifacts within Transect Recording Units (TRUs) and off-transect observations. Although many of these sites may represent Archaic manifestations, it would be unwise to assign them as a group to that period, given the nonsite orientation of the Border Star 85 survey. It is equally likely that many Lithic Unknown sites contain ceramics overlooked during the Phase I survey. Only 27 (3.7%) properties were judged (on the basis of collected projectile points) to be Archaic in affiliation.

The majority of the 253 (34.9%) Formative stage sites were assigned to the Unknown Formative category due to the ubiquity and nondiagnostic nature of El Paso Brownware body sherds and/or as a result of the nonsite sampling methods used during the Border Star 85 survey. Of those sites placed in more specific temporal categories, 12 (1.7%) are Mesilla phase, one is Doña Ana phase (0.1%), and 32 (4.4%) are El Paso phase. This group of sites also includes ceramic sites which were classified Multicomponent sites, usually due to the presence of Archaic projectile point types.

Owing to the major differences in the Border Star 85 data from the other two GBFEL-TIE alternatives, consideration of site structure and assemblage content in the Orogrande Alternative is presented in the following analytical chapter.

Chapter 4

# PREDICTION MODEL AND PROJECTED IMPACTS

## The Prediction Model

An important goal of the GBFEL–TIE sample survey was the development of a predictive model upon which to base projections concerning the nature and distribution of cultural resources in the three alternative facility locations for the GBFEL–TIE project: Stallion, NASA, and Orogrande. The model itself consists of a series of analytically based statistical projections (in tabular form) which summarize relevant site characteristics by environmental zones both within alternatives and by each alternative. An evaluation of the statistical significance of both the environmental and inter–alternative components of the projection is also included. The purpose of these projections is to assess the potential impacts of the GBFEL–TIE facility on each of the alternatives and to anticipate the relative efforts required to mitigate adverse impacts in each area.

The modeling process uses sample survey data from the three alternatives to project the site area densities (total square meters of site area per kilometer squared) for a variety of site attributes for each of the three alternatives. In addition, the model attempts to determine whether or not site area densities covary with different environmental zones identified in each area. The role of the environmental component in the model is to permit evaluation of the possible effects upon cultural resources which may result from differing placement of the facility within each alternative.

Because the model is based on sample data, statistical tests were used to determine the strength of the observed patterning. Although site counts are discussed in a few cases, the model emphasizes site area estimates (total site area per kilometer squared), due to the considerable variation observed in site size. Thus, total site area is thought to provide a more useful measure of the presence and extent of cultural remains than site frequencies. Additionally, it is argued that site area comparisons are much better reflections of the relative work effort required for various forms of scientific data recovery.

The goal of this approach is to provide relevant data in terms of the average amount of site area (in square meters) that will be disturbed for each square kilometer of construction. Specific details concerning potential GBFEL–TIE facility locations, dimensions, and construction elements are unknown at this writing. For the purposes of the discussion of potential impacts and mitigation efforts, it is assumed that the GBFEL–TIE facility will occupy an area on the order of 2 x 5 km (or 10 km$^2$), and that total destruction of cultural resources will result from this construction.

Based on these considerations, the prediction model discussed below is framed in terms of the average site area density in each alternative or environmental zone. The resulting figures, usually expressed in terms of square meters of site area per kilometer squared, can easily be multiplied by 10 to obtain estimates of total square meters of site area that will be affected by a hypothetical 10 km$^2$ facility. These figures are, in turn, used to compare the GBFEL–TIE alternatives in terms of three cultural resource management strategies: 1) 100% survey, 2) intensive surface recording, and 3) excavation.

The environmentally stratified prediction model developed herein is not based on any theoretical understanding of the adaptive systems in question. Rather, the model is essentially a *projection* from sample survey data based on several assumptions (see McAnany and Nelson 1982, for a discussion of theoretical versus projective predictive modeling). These assumptions include relative homogeneity within the environmental zones chosen, no change in environmental parameters over time, and a real and significant covariant relationship between the environmental and cultural parameters chosen. While the model described herein suggests interesting and believable relationships between slope (the principle environmental criterion used) and the kinds, sizes, and ages of sites found in the three alternatives, statistical tests suggest that much of the observed patterning lacks statistical significance and is largely a result of low sampling fractions.

The following sections discuss:

1) The *environmental stratification* of the three alternatives;

2) The nature of the *sample survey data sources* from each GBFEL–TIE alternative;

3) An *evaluation of sample reliability*;

4) A discussion of the *results of the prediction model analyses*; including a *statistical evaluation* of the predictive model; and

5) The *projected impacts* on each alternative of a hypothetical 2 x 5 km facility.

The estimated work effort required for various data recovery strategies is discussed in Chapter 5.

## Environmental Stratification

The environmental stratification used for all three alternatives is a simple one based on topography and is derived from observations in both the Border Star 85 and GBFEL–TIE surveys. These observations suggest that an important environmental dividing line occurs in the basin–range environments of southern New Mexico between the alluvial fans at mountain or hill bases and the true basin floor. This zone, termed the zone of energy transfer (Noyes and Schmader 1986), is the point at which slopes change from more than 2.5 degrees to fewer than 2.5 degrees. It is here that mountain or hill drainages fan out, providing potentially highly arable land. This fan zone was further subdivided into lower, middle, and upper segments to accommodate the NASA Alternative, which lies entirely on an extensive alluvial fan landform.

The stratification used for the prediction model analysis consisted of dividing each area into zones based on the topographic criteria described above. In order to simplify stratification computations, UTM lines were used to define zone boundaries in a first–order approximation of the underlying contour lines. As a result, the maximum deviation between actual contours and their UTM approximations was 0.5 km. Figure 1.1 shows the disposition of the three GBFEL–TIE alternatives in the Jornada del Muerto/Tularosa Basin region of southern New Mexico. Figures 4.1, 4.2, and 4.3 present the boundaries of the individual environmental zones defined within each of these alternatives.

In all, five different zones were defined. The Lower Fan zone is the gently sloping fan area adjacent the true (largely flat) basin floor; the Upper Fan area slopes more steeply and is adjacent to the mountain foothills, while the Middle Fan lies between these two. This division was necessitated for the most part by the considerable size of the alluvial fan zone on the west side of the San Andres Mountains, encompassed by the NASA Alternative. It seems probable that alluvial fan size is, in general, a function of the adjacent mountain mass.

The Basin Floor zone is extensively represented in the region as a nearly flat, poorly drained, old geomorphic surface characterized by occasional playas and an active eolian mantle. The Base of Hills zone was defined in the Stallion Alternative because, although the slopes were similar to those of the fan zones, the hills present in the northern portion of the survey do not qualify as mountains nor do the slopes appear to exhibit the same drainage characteristics.

Table 4.1 presents total area, surveyed area, sampling fractions, and stratification criteria for each of the GBFEL–TIE alternatives.

## Sample Survey Data Sources

For the Orogrande Alternative, projections are based on data from the Phase 1 Border Star 85 survey conducted in 1984 and 1985 (Seaman et al. 1986). As a result of the nonsite strategy used for this study, many sites lack requisite documentation for comparative purposes, and with the exception of extremely dense site areas, variables of artifact density, site counts of small sites, and site area

Table 4.1. GBFEL–TIE Alternatives and environmental strata

| Alternative | Environmental Zone | Total Area ($km^2$) | Survey Area ($km^2$) | No. Sample Units* | Sampling Fraction** | Boundary Criteria |
|---|---|---|---|---|---|---|
| NASA | Lower Fan | 24.0 | 3.00 | 12 | 12.5 % | 4500–4800' elev |
| | Middle Fan | 14.0 | 2.50 | 10 | 17.9 % | 4800–5000' elev |
| | Upper Fan | 18.0 | 2.25 | 9 | 12.5 % | over 5000' elev |
| | NASA total | 56.0 | 7.75 | 31 | 13.8 % | |
| Stallion | Basin Floor | 39.0 | 5.50 | 22 | 14.1 % | <2.5 deg slope |
| | Hill Base | 15.0 | 2.25 | 9 | 15.0 % | >2.5 deg slope |
| | Stallion total | 54.0 | 7.75 | 31 | 14.4 % | |
| Orogrande | Basin Floor | 48.0 | 48.00 | 200 | 100.0 % | <4190' elev |
| | Lower Fan | 11.4 | 11.40 | 52 | 100.0 % | >4190' elev |
| | Orogrande total | 59.4 | 59.40 | 252 | 100.0 % | |

* 500 x 500 m units (0.25 $km^2$)

** Orogrande Alternative sampling fraction not directly comparable to NASA and Stallion figures. Border Star 85 survey was a non–site survey that inventoried artifacts from a 6.0% sample of the project area. (Chapter 2)

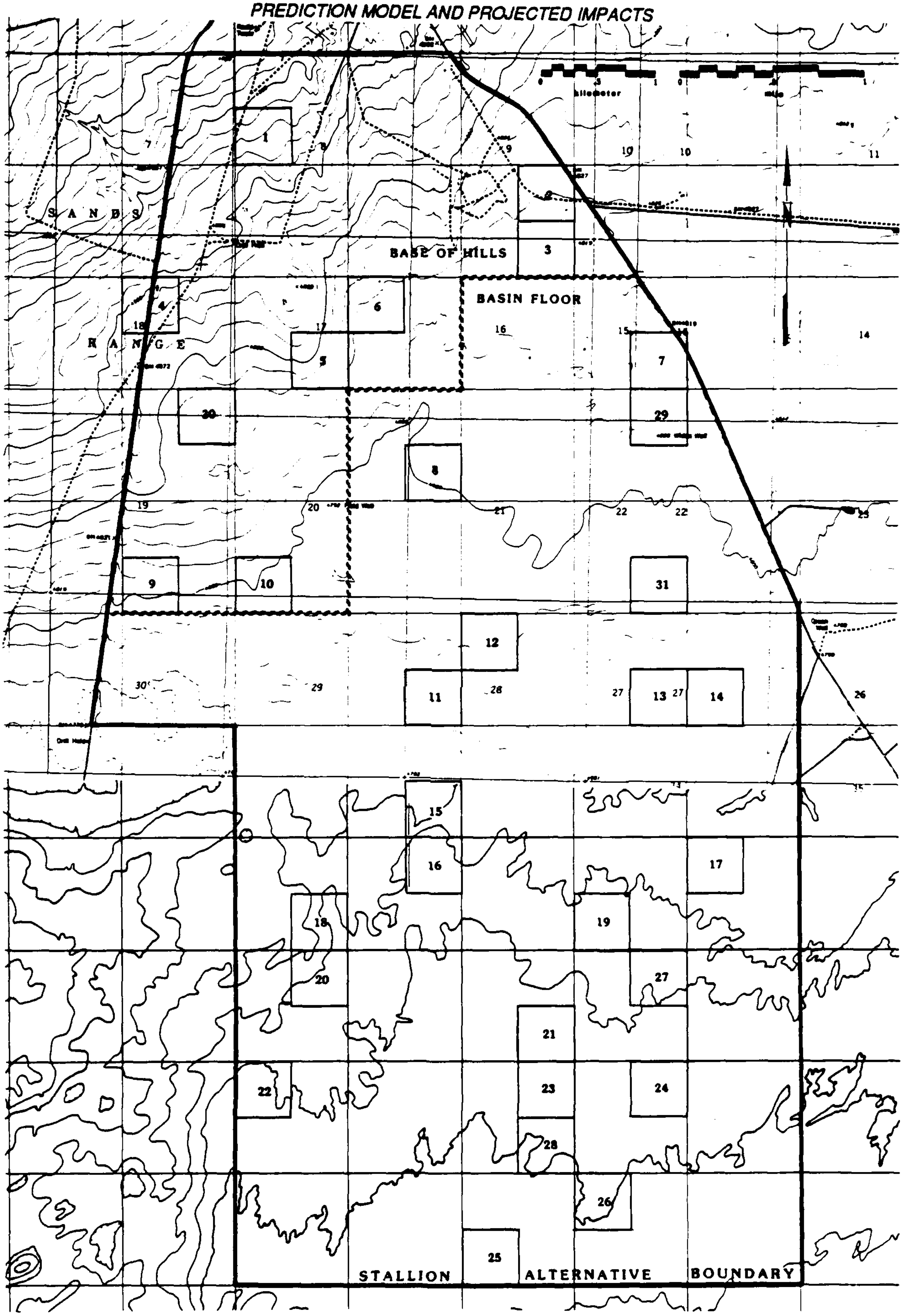



Figure 4.1 Stallion Alternative area and sample survey units

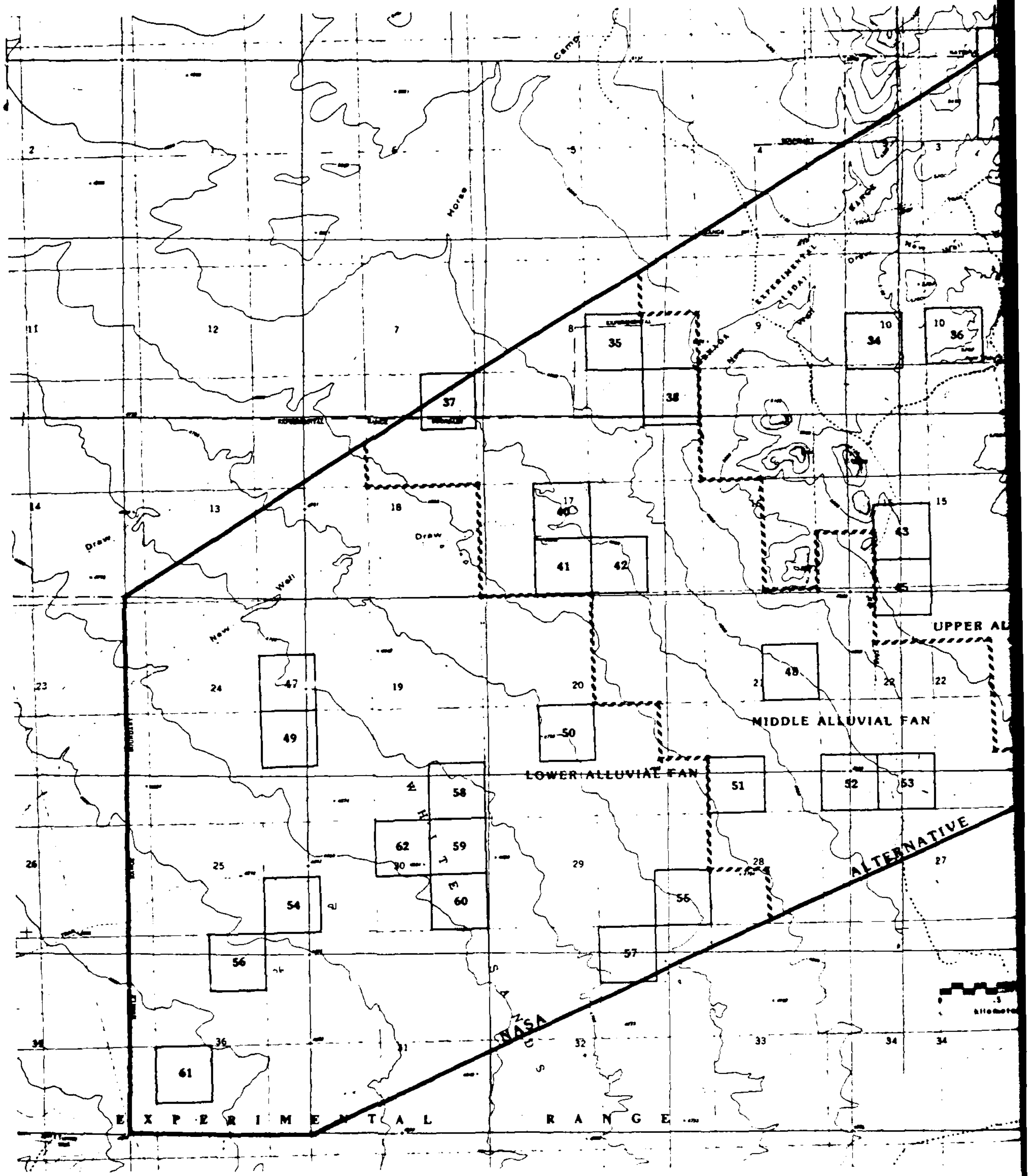
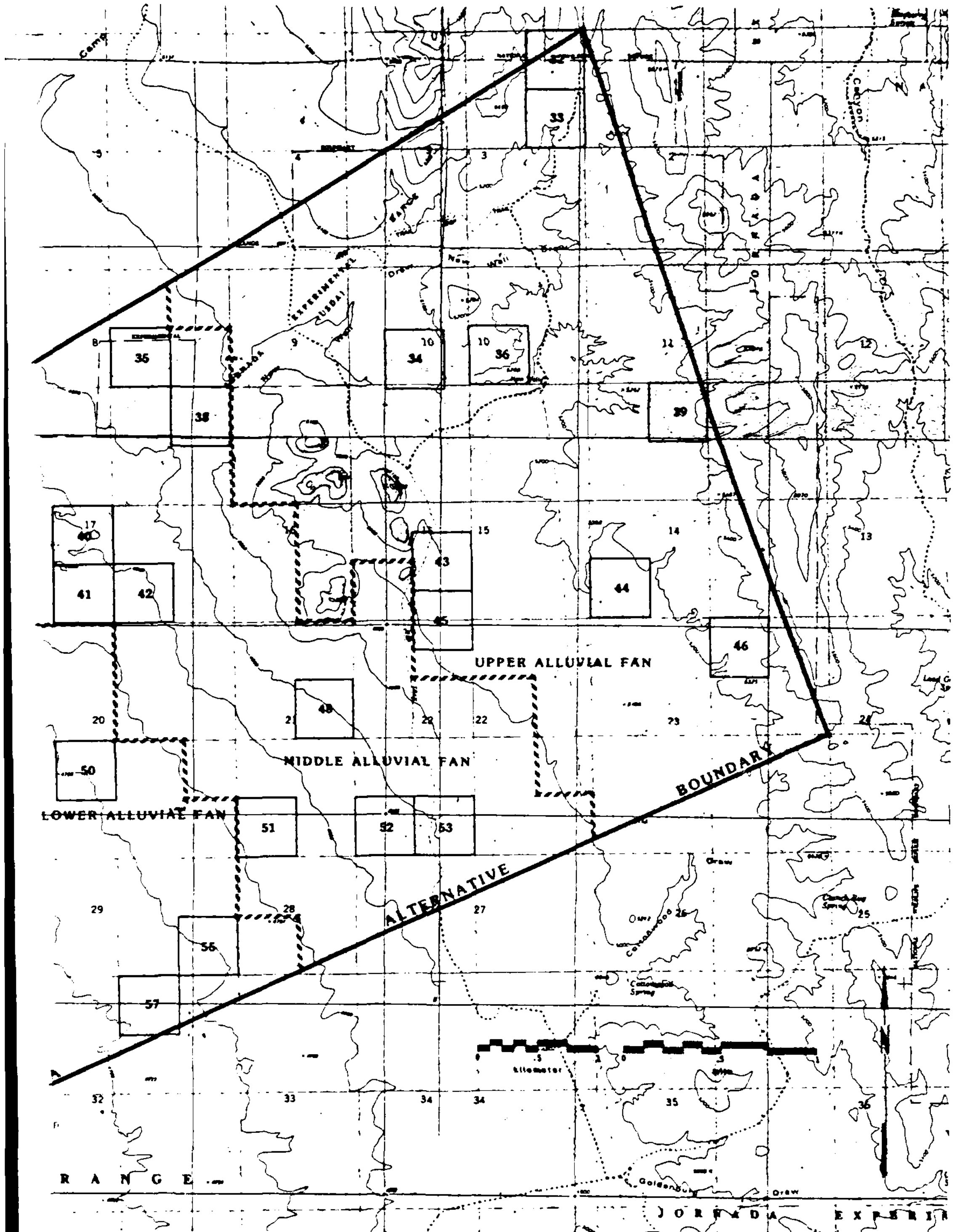





Figure 4.2 NASA Alternative area and sample survey un

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A Alternative area and sample survey units

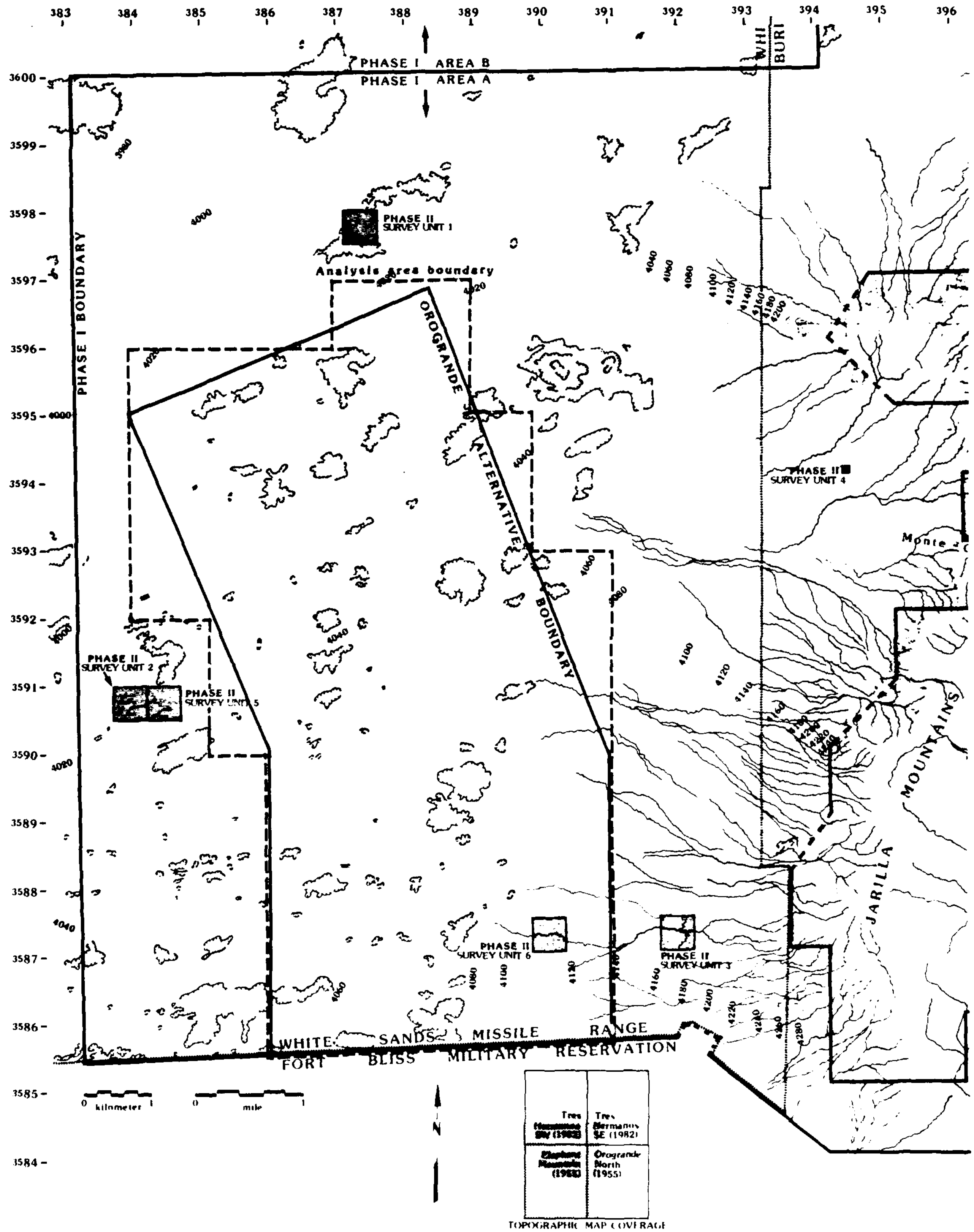



Figure 4.3 Orogrande Alternative area and analysis area boundaries

were significantly underestimated. For the purposes of projection, artifact count estimates have been adjusted by the factor of three as indicated by the Border Star 85 calibration analysis (Doleman 1986). In addition, based on this calibration, it was estimated that one out of three small sites were missed by the transect survey method and that site areas were underestimated by from 20 to 50%. Adjustments to site area and small site counts were not made for the current projections of the GBFEL–TIE Orogrande Alternative because of uncertainties concerning differences (in terms of defining sites) between the Border Star 85 and GBFEL–TIE surveys, which mostly affects small sites and site boundaries which affect site area.

For the purposes of developing the prediction model, the Orogrande data were divided into 0.25 $km^2$ (500 x 500 m) grid units which were treated in the same fashion as the 0.25 $km^2$ units of the Stallion and NASA Alternatives. In other words, they were analyzed as a 100% sample of the Orogrande Alternative. Although it might seem more equitable to select a 15% sample of 0.25 $km^2$ units from the Orogrande area, as was done for the other alternatives, this was not done because the larger sample size would increase the precision of the predictions for the Orogrande Alternative. It was believed that increased precision of the prediction for any of the areas was desirable for planning purposes, if it could be achieved. Furthermore, increased sampling fractions can only have a positive effect on statistical comparisons.

Data from both the NASA and Stallion Alternatives consist of site information from 31 quadrats (0.25 $km^2$); 62 quadrats total (15.5 $km^2$). The survey was site-oriented, and as a result of this site orientation, data are consistently more comparable from site to site, although data from some very large sites are incomplete. This is due to the 25 m transect spacing which was closer than in the Border Star 85 survey (33.3 m) and to the fact that the Border Star 85 site data were gathered only from within transect boundaries, whereas the GBFEL–TIE survey methods emphasized sampling the entire site. Thus site discovery rates and site area estimates are expected to be more reliable for the Stallion and NASA Alternatives.

The 31 units (0.25 $km^2$) surveyed in each of the GBFEL–TIE alternatives were chosen using a stratified random unaligned sampling design. Use of this design was based on Plog's (1976) discovery that such samples consistently yielded more precise results than simple random samples, when applied to a known population of site survey data. This pattern held both overall and when site distributions were structured by underlying environmental parameters. In stratified random unaligned sampling, the sampling universe (in this case a GBFEL–TIE alternative) is divided into equal-sized square quadrats (strata), each of which is further divided into ($n$) whole quadrats (sample units). Thus ($n$) is always a square number such as 4 or 25, and the size of the larger quadrats is a multiple of the size of the small ones. The actual sample is chosen by randomly picking one or more ($k$) small quadrats from each large one, resulting in a sampling fraction of $k/n$.

For the GBFEL–TIE survey, the Stallion and NASA Alternatives were divided into strata measuring 2 km on a side (or 4 $km^2$), each encompassing 16 possible 500 x 500 m sample units. Two sample units were chosen randomly from each stratum yielding a theoretical sampling fraction of 2/16 or 12.5%, consisting of 26 units. Because the alternative boundaries do not coincide with UTM lines, only potential sample units which fell at least halfway inside the alternative were included in the sample. As a result, some surveyed units fell partially outside the actual alternative boundaries. However, to require that all sample units lie entirely inside the alternative would bias the sample towards the middle of the area. Since 31 units were required to approximate a 15% sample of each area, the remaining 5 units were, at the request of the CE, placed in a fashion designed to fill in gaps resulting from the stratified random unaligned sampling design.

**Evaluation of Sample Reliability**

It is believed that the spatial sample achieved by the above methods is at least representative of the general characteristics of the Stallion and NASA Alternative survey areas. The locations of the individual survey units are indicated in Figures 4.1 and 4.2. The spatial sample for Orogrande is similar in that the transect recording units are quadrats, but considerably different in terms of their very small size (2.0 x 33.3 m), the much higher number of samples (almost 20,000 units), and their systematic placement on the landscape (Figure 4.3).

The accuracy and reliability of this prediction model is a function not only of the environmental assumptions described above, but of the quality and reliability of the sample data upon which the model is based. The quality of sample survey data is subject to the effects of the nature of the sampling strategies used and geomorphological bias.

In addition to the traditional belief that prehistoric settlement was significantly influenced by environmental variables, it has become clear that the visibility of archeological remains is also a function of such parameters. For example, it has been suggested that the frequently observed correlation between Archaic assemblages and eolian contexts in the San Juan Basin region of New Mexico is simply due to the fact that the dunes represent the oldest land surfaces present (McAnany and Nelson 1982:78).

The possible effects of large-scale (zone-to-zone) variation in geomorphic factors on archeological visibility in the three GBFEL–TIE alternatives has not yet been investigated. A significant correlation between major geomorphic factors and the zones might be expected, however, due to the use of topography (slope) as a criterion in zone definition. It was also abundantly clear dur-

ing the field effort that the mesquite–coppice eolian mantle has a significant small–scale effect on visibility. Many large sites have extensive areas of low or zero artifact density which correspond exactly with areas of increased sand depth and high coppice dunes. Thus the low density areas probably contain equally high artifact densities which merely have been concealed by the highly mobile eolian mantle.

The effects of this factor on the sample data from the three GBFEL–TIE alternatives depend on the survey strategies used. In the Orogrande area, where transect–based recording was used during the Border Star 85 Phase I survey, subsequent fine–grained inventory of selected areas revealed that recorded site data varied as a function of the regular and systematic placement of the transect recording units versus the essentially random locations of high–visibility blowouts. As a result, small sites were missed in an inverse proportion to their size, artifact density estimates fluctuated wildly, and the minimum sample size required for adequate quantitative estimates of density was subsequently determined to be 0.25 to 1.0 $km^2$ (Doleman 1986). In addition, the criteria for site boundary definition during the Border Star 85 survey varied among field personnel; some personnel divided different blowouts containing artifacts into many small sites, while others combined different nearby blowouts into large dispersed sites.

In the Stallion and NASA Alternatives, extensive areas of eolian sand with intermittent artifact–bearing blowouts were generally lumped into large dispersed sites. Artifact density estimates for these sites are necessarily based on the highest observed densities, i.e. those in the blowouts, rather than those between blowouts. Thus, estimates of visible artifact density may be overestimations of overall site density. On the other hand, such estimates constitute the only possible sources of estimates for the artifact content of the intervening eolian matrix.

The accuracy and quality of the Border Star 85 data for the Orogrande Alternative have been discussed in detail by Seaman et al. (1986). It is presumed that the data, although not directly compatible with those collected in the present GBFEL–TIE sample survey, are capable of providing reasonably accurate estimates of site numbers, site areas, and artifact densities at the 0.25 $km^2$ level of resolution. The greatest drawback of the Border Star 85 data lies in the failure of the sample to discover rare artifacts. Estimates of lithic and ceramic artifact diversities are thus unrealistically low and many sites fall into unknown cultural/temporal categories because low frequency, temporally diagnostic items were not discovered.

Most of these shortcomings were avoided in the site–oriented GBFEL–TIE survey methods. The GBFEL–TIE data, however, are subject to a different set of sampling problems. Since most archeological data result from sampling space rather than populations of items, such data represent, in statistical terms, cluster samples rather than element samples (Mueller 1975). As a result of the mathematics of cluster sampling and the fact that archeological materials tend to cluster in space, spatial samples (e.g., grids) tend to be high in variance and low in precision or reliability Increased accuracy and high precision are achieved only by the use of high sampling fractions and the use of as many small sample units as possible (Nance 1981; Plog 1976; Read 1975).

In other words, when sampling fractions are low and/or sample units (grids) are large, the variance among the individual cluster samples (grids) is high and statistical comparisons between samples (groups of grids) tend to yield nonsignificant results. This relationship is due to the fact that the power of a statistical test (the ability to reject the null hypothesis of no significant difference when there is a difference) is a function of sample size. Small samples reduce statistical power (Blalock 1979:252). Furthermore, power is a function not only of differences in central tendency but of sample overlap (the degree to which the sample distributions coincide). Since overlap reflects variance, high variance reduces power (Blalock 1979:250). For the GBFEL–TIE data, the grids are large (500 m), the sampling fractions low (12–15%), and the absolute numbers of sample units low (31 for each alternative), so it is expected that statistical comparisons between samples will yield nonsignificant results.

Much has been written about adequate sampling fractions in regional survey (Cowgill 1975; Judge 1981). The only certain conclusions appear to be:

> 1) Sampling fractions and absolute sample sizes need to be carefully chosen after a detailed assessment of known or estimated population and sampling design attributes.
>
> 2) Absolute sample size is far more important than sampling fraction in determining sample precision.

Evaluations of regional sampling methods usually involve comparing different designs (e.g., simple random versus systematic, transects versus quadrats) using multiple independent sampling runs against a single known population at a specified sampling fraction. Examples include Sanders et al. (1979) Plog (1976), and Judge et al. (1975).

Judge et al. (1975:114–115) found that, at a sampling fraction of approximately 20%, most transect designs were effective in discerning environmental variations in a variety of single site attributes (e.g., time period), but that variability in combined attributes (e.g., site function and time period) was less easily detected, largely due to the resulting small sample sizes.

Sanders et al. (1979: Tables E.1–E.4) also used a target sampling fraction of 20% in comparing sample designs (large–small, transect–quadrat) for predictability (i.e., accuracy). Their results indicate that all designs based on site size and density measures were inaccurate in predicting total prehistoric population, as determined from site

size and ceramic density. Fifty percent of the evaluated designs were inaccurate for estimating total site count. Forty percent of the designs were inaccurate in estimating the prehistoric population distribution among site types, but all the designs accurately predicted the site type breakdown in terms of site counts.

Plog (1976) not only compared different designs (large–small transect–quadrat) in terms of relative precision, but evaluated the the effects of variations in the distributional character of the target data on precision. With a target sampling fraction of 10%, Plog found that precision is reduced when site sizes are small and sites are clustered (Plog 1976:153–157). Plog also notes, as does Nance (1981) that smaller sample units yield greater precision. Plog does not, however, specify what an adequate size would be, although his quadrat units were either 1000 m or 500 m on a side, suggesting that a drop below 500 m might yield more reliable results. Nance (1981:165) simply suggests "as large a number of small units as possible." Finally, Plog's results are expressed as relative efficiencies and his comparisons with the target population are not presented, hence these results say little about the value of the 10% sample.

Other studies include that of Judge (1981) in which he found that, although survey intensity significantly affected sample estimates, a single 15.5% transect sample was generally adequate for reflecting variations in site attributes versus environmental zones. Chenhall (1975) concluded that a 50% sample was the minimum acceptable, but has been rightly criticized on mathematical grounds by Cowgill (1975:268–269).

These studies make it difficult to decide whether 10%, 20%, or some other fraction is generally appropriate for survey. Certainly, any attempt to derive an all–purpose sampling fraction from them would be doomed to fail. Perhaps the best commentary is that of Cowgill:

> ...it is probably impossible to attack too often the persistent delusion that there is some special merit in a 10% sample...Unless the sampling fraction is more than 20% of the total population, the *proportion* of the population included in the sample is of negligible importance. What is virtually all–important is the absolute size of the sample [Cowgill 1975:263].

According to Cowgill, sample size alone, rather than sampling fraction, matters with fractions below 20%. Other critical considerations discussed in these studies are the negative effects on precision of large sample units and aggregation in the target population. The former reduce absolute sample size at a given fraction in spatial samples, while the latter increase sample variance. Both factors are characteristic of the GBFEL–TIE sample survey data.

Thus, from both theoretical and empirical perspectives the typical sample survey of 10% and the incorporation of large (0.25 km$^2$ to 1 mi$^2$) sample units are expected to have little value in *predicting* the actual content of the cultural landscape. Such strategies assume, often mistakenly, spatial homogeneity of archeological distributions and thus lack reliability because they lack precision. Imprecision means that the odds that a particular sample is accurate are very low, because precision and sample variance are inversely related.

Spatial aggregation of cultural resources is evident in all three alternatives, including Orogrande where, although archeological remains are nearly ubiquitous, site materials are clustered inside site boundaries. Nonetheless, there are some demonstrable differences among the GBFEL–TIE alternatives and among the different environmental zones in each alternative. These differences are sufficiently obvious to form the basis for intelligent management decisions.

## Prediction Model Analysis

The essential role of the prediction model in the GBFEL–TIE survey is a managerial one in which one seeks to anticipate the nature and distribution of cultural resources in each of the three alternatives and to compare them in terms of the potential impacts and data recovery requirements of a hypothetical 2 x 5 km facility. Because site sizes vary considerably in the region and criteria for site boundary definition continue to be controversial, site area (expressed as total site area/km$^2$) has been chosen over the more traditionally used site frequency as a more useful measure of impact and mitigation costs.

Several site characteristics chosen for analysis and projection are intended to be useful in anticipating the kinds, complexity, and extent of cultural resources that will be impacted by construction activities. The rationale behind the choice of these parameters includes several factors. First, large sites generally require more extensive data recovery efforts. As noted previously, although much of the surface of any given site in the three surveyed alternatives often exhibits low or zero density, it is suspected that such low density areas are the product of a geomorphic mask, resulting from a very dynamic eolian environment. On the other hand, while small sites may be simpler and easier to excavate, the logistical cost of accessing them is considerable higher because of their greater numbers.

Second, sites containing architecture or features such as hearths or middens are also more expensive to record or excavate. Unfortunately, the fragile nature of adobe architecture together with the effects of eolian deposits on visibility lend a considerable degree of uncertainty to the representativeness of the architecture/feature data from either the GBFEL–TIE or Border Star 85 surveys. As a result, features are thought to be significantly underrepresented in both survey data bases.

Surface artifact diversity, however, may be a useful clue to the presence of subsurface architecture or features.

Yellen (1977) has confirmed Schiffer's (1972) theoretically based thesis that residential sites should exhibit greater artifact diversity due to longer occupation period and the performance of more complex activity sets. Since architecture and features are standard residential site characteristics, a correlation between them and higher artifact diversities is expected. Given the greater density of artifacts on sites, geomorphic factors may affect feature visibility more than the linked measure, artifact diversity.

Third, artifact diversity and number are both indicators of the amount of analytical effort required to mitigate adverse impacts adequately.

A reasonably accurate prediction model, which takes these parameters into consideration, should be capable of providing useful estimates of the amount of site area (or in some cases numbers of sites) of various types (e.g., high versus low artifact density, small versus large sites, Mesilla vs Doña Ana phases, low versus high artifact diversity), which will be impacted by construction activities once the nature and areal extent of the facility are known The sites and site area per kilometer squared figures presented in the tables form the core of the prediction model and can be multiplied by the known facility area ($km^2$) to derive estimates of total cultural resource impact. For the hypothetical 2 x 5 km facility (10 $km^2$), the figures should be multiplied by 10. For example, if the projected Archaic site area density for an alternative is 5000 $m^2/km^2$ then the model predicts that—on the average—50,000 $m^2$ of Archaic site will be destroyed by the facility.

Using these criteria, the following parameters were chosen as critical to assessing impact and projected in the prediction model:

1) Total sites and site area/$km^2$ by identifiable time period(s).

2) Total sites/$km^2$ by site size class ($m^2$).

3) Total site area/$km^2$ by overall artifact density (per square meter).

4) Total sites/$km^2$ by number of hearths per site.

5) Total sites/$km^2$ by number of structural features and middens per site. Data from the Orogrande Alternative are not included because none was recorded in the area represented.

6) Total site area/$km^2$ by artifact class diversity (number of classes present). Separate projections are provided for lithic and ceramic artifact diversities.

The marked differences between the two survey methodologies used for either the NASA and Stallion Alternatives or the Orogrande Alternative, raise critical questions regarding the comparability of the data bases and the resulting projections. Some of these differences have been discussed above, but not all possible effects have been defined (nor is it possible to do so without comparing them in terms of some baseline information). It can only be hoped that the general similarities in the results are an indication that the data are comparable. Of particular significance is the fact that the method used to derive site area estimates for the Border Star 85 data tends to overestimate small site areas. This is quite evident in the comparatively high estimates of site area densities for the normally small Lithic Unknown and Unknown Formative (ceramic unknown) sites in the Orogrande area (Table 4.2).

**Results**

Tables 4.2–4.10 contain the results of the predictive analyses for all three alternatives by environmental stratum. Each table consists of a projection of either total sites and site density (sites/$km^2$) and/or total site area and site area density (site area ($m^2$)/$km^2$) for each of the environmental strata present in the alternative. The projections presented are for the individual environmental zones and represent actual site counts or site area totals for each zone adjusted by the sampling fractions in Table 4.1 (adjustment factor=1 + sampling fraction).

Tables 4.2, 4.3 and 4.4 present site count and site area projections and site area densities by culture/temporal period for the Stallion, NASA, and Orogrande alternatives. Due to differences in the data bases, the chronological periods for the Orogrande sites were derived using ceramics and projectile points independently. The figures presented are for components and are not additive.

An inspection of these tables indicates that many site/component types appear to increase in number or, more significantly, in areal extent in the alluvial fan zones or at higher elevations. Most obvious are the marked increases in site area density for Archaic and Multicomponent (Preformative and Formative) sites in the Stallion Alternative and in the Mesilla phase sites in Orogrande. Overall, the Orogrande Alternative exhibits the least amount of inter-zonal variation.

Notable exceptions to this pattern are the El Paso phase sites and Multicomponent site types in the NASA Alternative, and the Lithic Unknown and Formative Multicomponent sites in the Stallion area. Combining all periods, NASA shows a general decline in overall site area density at higher elevations, while the Orogrande and the Stallion Alternatives indicate increased densities at higher elevations.

Tables 4.2–4.4 also demonstrate that site densities and site area densities are highest by far in the NASA Alternative. For example, while Multicomponent site area densities range from ca. 200–15,000 $m^2/km^2$ in the Stallion and Orogrande Alternatives, they range from ca. 3200–270,000 $m^2/km^2$ in the NASA area. Thus in the

Table 4.2. Orogrande Alternative projections: Chronological periods

| Chronological Period | Number of Sites | Site Density (per km$^2$) | Site Area per km$^2$ | Average Site Area* |
|---|---|---|---|---|
| **Basin Floor** (48 km$^2$) | | | | |
| Paleoindian | 1 | 0.02 | 61 | 2618 |
| Archaic | 31 | 0.72 | 2040 | 2843 |
| Mesilla | 6 | 0.14 | 202 | 1455 |
| Doña Ana | 0 | – | – | – |
| El Paso | 27 | 0.03 | 2000 | 3200 |
| Multicomponent (Formative) | 1 | 0.02 | 202 | 8727 |
| Unknown Formative | 166 | 3.84 | 6627 | 1725 |
| Lithic Unknown | 313 | 7.25 | 9779 | 1350 |
| Unknown (No Artifacts) | 23 | 0.53 | 525 | 987 |
| **Lower Alluvial Fan** (11.4 km$^2$) | | | | |
| Paleoindian | 0 | – | – | – |
| Archaic | 13 | 1.12 | 2760 | 2484 |
| Mesilla | 9 | 0.77 | 2984 | 3491 |
| Doña Ana | 1 | 0.09 | 3506 | 41020 |
| El Paso | 7 | 0.60 | 1715 | 2867 |
| Multicomponent (Formative) | 0 | – | – | – |
| Unknown Formative | 54 | 4.62 | 8130 | 1762 |
| Lithic Unknown | 79 | 6.75 | 7236 | 1072 |
| Unknown (No Artifacts) | 11 | 0.94 | 1044 | 1110 |
| **Mean Site Area per km: All Zones** (59.4 km$^2$) | | | | |
| Paleoindian | | | 49 | |
| Archaic | | | 2184 | |
| Mesilla | | | 758 | |
| Doña Ana | | | 701 | |
| El Paso | | | 1943 | |
| Multicomponent (Formative) | | | 162 | |
| Unknown Formative | | | 6928 | |
| Lithic Unknown | | | 9270 | |
| Unknown (No Artifacts) | | | 629 | |

* *Site area in m$^2$*

NASA Alternative, from 32,000 to 2,700,000 m$^2$ of various types of Multicomponent site areas are projected for a 2 x 5 km facility. Similarly, although Archaic site area density is highest in the Stallion area Base of Hills zone (ca. 25,000 m$^2$/km$^2$), it is most consistently high in the NASA Alternative, ranging from 1000–15,600 m$^2$/km$^2$ (10,000–150,000 m$^2$ for a hypothetical 2 x 5 km facility).

Table 4.5 shows the projected distribution of sites by size for each alternative. The highest site densities overall (8–10/km$^2$) are for small sites (<1000 m$^2$) in the Orogrande area. More significantly, however, the per kilometer squared density of sites with areas greater than 20,000 m$^2$ is 0.4 or less in the Stallion and Orogrande Alternatives, while it ranges from 0.3–0.8 in the NASA area. In addition, the NASA Alternative is the only one with sites larger than 50,000 m$^2$ (some NASA sites even exceed 200,000 m$^2$).

Thus, on the average, the model projects that a 2 x 5 km facility in the NASA Alternative would impact five very large sites, each ranging from 50,000 m$^2$ to more than 200,000 m$^2$ in extent. For the Stallion area the facility would impact four large sites (each ranging from 20,000–50,000 m$^2$ in extent) and a variety of small to medium ones. In the Orogrande Alternative, two to four medium-size sites (2000–20,000 m$^2$) and numerous small sites would be impacted.

No clear relationship between site size and elevation emerges in Table 4.5. The abundance of small (0–2000 m$^2$) sites appears to increase in the Stallion and Orogrande areas but declines in the NASA Alternative. Medium-sized (2000–20,000 m$^2$) site densities increase somewhat in the Stallion area but exhibit little change as a function of elevation in either Orogrande or NASA. NASA Alternative large site (20,000–200,000 m$^2$)

Table 4.3. Stallion Alternative projections: Chronological periods

| Chronological Period | Total Sites | Pct. of Zone | Sites per km$^2$ | Total Site Area* | Pct. of Zone | Site Area per km$^2$ |
|---|---|---|---|---|---|---|
| **Upper Basin Floor** (39 km$^2$; 22 survey units) | | | | | | |
| Archaic | 7 | 6.3 | 0.18 | 28399 | 5.1 | 728 |
| Lithic Unknown | 71 | 62.5 | 1.82 | 209865 | 37.4 | 5382 |
| Multicomponent (Formative) | 7 | 6.3 | 0.18 | 109142 | 19.4 | 2799 |
| Multicomponent (Pre/Formative) | 21 | 18.8 | 0.55 | 186489 | 33.2 | 4782 |
| Historic | 7 | 6.3 | 0.18 | 27508 | 4.9 | 705 |
| **Base of Hills** (15 km$^2$; 9 survey units) | | | | | | |
| Archaic | 40 | 42.9 | 2.67 | 373802 | 61.7 | 24908 |
| Lithic Unknown | 13 | 14.3 | 0.89 | 7098 | 1.2 | 473 |
| Multicomponent (Pre/Formative) | 40 | 42.9 | 2.67 | 225041 | 37.1 | 14995 |
| **Mean Site Area per km All Zones** (54 km$^2$; 31survey units) | | | | | | |
| Archaic | | | | | | 7748 |
| Lithic Unknown | | | | | | 3957 |
| Multicomponent (Formative) | | | | | | 1986 |
| Multicomponent (Pre/Formative) | | | | | | 7747 |
| Historic | | | | | | 501 |

** Site area in m$^2$*

Table 4.4. NASA Alternative projections: Chronological periods

| Chronological Period | Total Sites | Pct. of Zone | Sites per km$^2$ | Total Site Area* | Pct. of Zone | Site Area per km$^2$ |
|---|---|---|---|---|---|---|
| **Lower Alluvial Fan** (24 km$^2$; 12 survey units) | | | | | | |
| Archaic | 32 | 19.0 | 1.33 | 98225 | 0.8 | 4093 |
| Lithic Unknown | 8 | 4.8 | 0.33 | 9651 | 0.1 | 402 |
| Mesilla | 8 | 4.8 | 0.33 | 20106 | 0.2 | 838 |
| El Paso | 24 | 14.3 | 1.00 | 2579254 | 21.1 | 107469 |
| Multicomponent (Formative) | 48 | 28.6 | 2.00 | 3036669 | 24.9 | 126528 |
| Multicomponent (Pre/Formative) | 48 | 28.6 | 2.00 | 6462773 | 52.9 | 269282 |
| **Middle Alluvial Fan** (14 km$^2$; 10 survey units) | | | | | | |
| Archaic | 6 | 5.3 | 0.40 | 14008 | 0.4 | 1001 |
| Mesilla | 11 | 10.5 | 0.80 | 3659 | 0.1 | 261 |
| El Paso | 22 | 21.1 | 1.60 | 125086 | 3.2 | 8935 |
| Multicomponent (Formative) | 34 | 31.6 | 2.40 | 1116492 | 28.1 | 79749 |
| Multicomponent (Pre/Formative) | 34 | 31.6 | 2.40 | 2711733 | 68.3 | 193695 |

(continued)

Table 4.4. (continued)

| Chronological Period | Total Sites | Pct. of Zone | Sites per km2 | Total Site Area* | Pct. of Zone | Site Area per km2 |
|---|---|---|---|---|---|---|
| **Upper Alluvial Fan** (18 km2; 9 survey units) | | | | | | |
| Archaic | 24 | 27.3 | 1.33 | 280859 | 28.6 | 15603 |
| Lithic Unknown | 16 | 18.2 | 0.89 | 11938 | 1.2 | 663 |
| Mesilla | 8 | 9.1 | 0.44 | 135717 | 13.8 | 7540 |
| El Paso | 8 | 9.1 | 0.44 | 201 | 0.0 | 11 |
| Multicomponent (Formative) | 16 | 18.2 | 0.89 | 497629 | 50.6 | 27646 |
| Multicomponent (Pre/Formative) | 16 | 18.2 | 0.89 | 57177 | 5.8 | 3177 |
| **Mean Site Area per km2: All Zones** (56 km2; 31 survey units) | | | | | | |
| Archaic | | | | | | 6737 |
| Lithic Unknown | | | | | | 348 |
| Mesilla | | | | | | 2598 |
| El Paso | | | | | | 44486 |
| Multicomponent (Formative) | | | | | | 82730 |
| Multicomponent (Pre/Formative) | | | | | | 167643 |

* Site area in $m^2$

densities are highest in the Middle Fan, while the densities of very large sites (>200,000 $m^2$) decline with elevation. Many of the large and very large sites exhibit low overall artifact densities, partially as a function of the masking effects of the eolian surface matrix.

Table 4.6 shows the distribution of site area and projections of site area/square kilometer in terms of site artifact density (number of artifacts per square meter), a clue to both complexity and the extent of cultural remains. As with the other data, the NASA Alternative stands out. Artifact densities greater than 0.2 (1 artifact/5 $m^2$) are uncommon in the Stallion Alternative in terms of site area represented and occur only in the Base of Hills zone, indicating a correlation of density with increased slope and elevation. In the Orogrande Alternative, sites at this level of artifact density are more common and show a similar association with elevation and slope. Densities greater then 1 artifact/$m^2$ are absent in Stallion and fairly rare in the Orogrande area.

It is clear, however, that vast portions of the NASA Alternative exhibit high artifact densities on the order of one or more artifacts per square meter. For example, the model predicts that over 230,000 $m^2$/km$^2$ of the NASA Middle Fan zone has artifact densities in excess of 1 artifact/$m^2$. Interestingly, in the NASA Alternative the areal extent of sites with artifact densities of 1–5 artifacts/$m^2$ is high in the Lower Fan, higher in the Middle Fan, and drops off sharply in the Upper Fan; conversely, the areal extent of very high densities (>5 artifacts/$m^2$) increases steadily with elevation.

Tables 4.7 and 4.8 present projections of numbers of sites with varying numbers of hearths and structural features (including middens). No apparently massive structural features were recorded in the Orogrande portion of the Border Star 85 survey. The Orogrande Alternative, however, appears to exhibit the greatest overall densities of hearth–bearing sites, although this may be a function of different recording methods. All evidence of fire–using activities, including fire–cracked rock scatters, was recorded as hearths in the Border Star 85 data, while fire–cracked rock scatters tended not to be included in the hearth count for sites recorded during the GBFEL–TIE survey. Thus hearths may be considered as over–represented in the Border Star 85 data (or as underestimated by the GBFEL–TIE survey results). The safest conclusion was to assume that, if fire–cracked rock were included, the Stallion and NASA areas would compare more favorably with the Orogrande data. There is, however, no clear patterning in the distribution of hearths within the three alternatives. Densities of hearth–bearing sites increase slightly overall with elevation in the Stallion area, but decrease with elevation in NASA, and show little change in the Orogrande Alternative. Sites with many hearths (>5) appear to decline as elevation increases in both the NASA and Orogrande Alternatives.

In general, structural features (Table 4.8) appear to be rare occurrences, even in the high–density NASA area. In all likelihood, the actual occurrence of structural remains is much higher in all three areas and is masked by the eolian nature of the surface matrix. Additionally, the prehistoric use of adobe as a dominant building material tends to leave an ephemeral surface record of structures.

Table 4.5. Site size and environmental zones

| Stallion Alternative | Basin Floor | | Base of Hills | |
|---|---|---|---|---|
| Site Area ($m^2$) | Total Sites | Sites per $km^2$ | Total Sites | Sites per $km^2$ |
| 0–1000 | 35 | 0.9 | 47 | 3.1 |
| 1001–2000 | 28 | 0.7 | 7 | 0.4 |
| 2001–8500 | 28 | 0.7 | 20 | 1.3 |
| 8501–20000 | 7 | 0.2 | 13 | 0.9 |
| 20000–50000 | 14 | 0.4 | 7 | 0.4 |

| NASA Alternative | Lower Fan | | Middle Fan | | Upper Fan | |
|---|---|---|---|---|---|---|
| Site Area ($m^2$) | Total Sites | Sites per $km^2$ | Total Sites | Sites per $km^2$ | Total Sites | Sites per $km^2$ |
| 0–1000 | 32 | 1.3 | 22 | 1.6 | 24 | 1.3 |
| 1001–2000 | 24 | 1.0 | 11 | 0.8 | 8 | 0.4 |
| 2001–8500 | 48 | 2.0 | 28 | 2.0 | 32 | 1.8 |
| 8501–20000 | 16 | 0.7 | 11 | 0.8 | 8 | 0.4 |
| 20001–50000 | 8 | 0.3 | 11 | 0.8 | 8 | 0.4 |
| 50001–100000 | – | – | 11 | 0.8 | 8 | 0.4 |
| 100001–200000 | 16 | 0.7 | 6 | 0.4 | – | – |
| >200000 | 24 | 1.0 | 6 | 0.4 | – | – |

| Orogrande Alternative | Basin Floor | | Lower Fan | |
|---|---|---|---|---|
| Site Area ($m^2$) | Total Sites | Sites per $km^2$ | Total Sites | Sites per $km^2$ |
| 0–1000 | 385 | 8.9 | 117 | 10.0 |
| 1001–2000 | 91 | 2.1 | 32 | 2.7 |
| 2001–8500 | 71 | 1.6 | 14 | 1.2 |
| 8501–20000 | 9 | 0.2 | 4 | 0.3 |
| 20000–50000 | – | – | 1 | 0.1 |

The data from the GBFEL–TIE sample of the NASA Alternative suggest that structural sites are limited to the Lower and Middle Fan zones. However, extensive multiple-structure sites (e.g., LA 9069) are known to occur in the Upper Fan zone. It can be presumed that their absence from the GBFEL–TIE sample is simply a function of the randomness of the sample and the low sampling fraction [see also Duran (1982) for a discussion of high site densities on the Upper Fan in an area just south of the NASA Alternative].

Tables 4.9 and 4.10 show variations in the diversity at sites of both lithic and ceramic classes. Artifact diversity is similar to density as a measure of site complexity and size. Previous survey data have shown that high artifact diversity is almost always correlated with the presence and extent of architecture or other features at sites in the Jornada Mogollon region. Examples of this relationship may be found in sites such as documented in the foothills of the Jarilla Mountains during the Border Star 85 Project (Seaman et al. 1986) and by Carmichael's (1983) survey of Ft. Bliss.

In terms of environmental patterning, the figures in Table 4.9 suggest that the amount of site area with high lithic artifact diversity (≥ 6 types) tends to increase with slope and elevation in the Stallion and Orogrande Alternatives but declines in the NASA Alternative, especially in the Upper Fan zone. Site area with low to moderate lithic diversity (1–5 types) tends to increase in Stallion and Orogrande but declines in NASA. High ceramic diversities (≥ 6 types) are completely absent in the Stallion area (Table

Table 4.6. Site artifact density and environmental zones

| **Stallion Alternative** Artifact Density (items/m$^2$) | *Basin Floor* Total Site Area* | *Basin Floor* Site Area per km$^2$ | *Base of Hills* Total Site Area | *Base of Hills* Site Area per km$^2$ | *All Zones* Site Area per km$^2$ |
|---|---|---|---|---|---|
| ≤0.05 | 358688 | 9198 | 206627 | 13768 | 10778 |
| 0.06–0.20 | 175207 | 4493 | 336974 | 22454 | 10296 |
| 0.21–1.00 | 0 | 0 | 62340 | 4154 | 1298 |

| **NASA Alternative** Artifact Density (items/m$^2$) | *Lower Fan* Total Site Area* | *Lower Fan* Site Area per km$^2$ | *Middle Fan* Total Site Area | *Middle Fan* Site Area per km$^2$ | *Upper Fan* Total Site Area | *Upper Fan* Site Area per km$^2$ | *All Zones* Site Area per km$^2$ |
|---|---|---|---|---|---|---|---|
| ≤0.05 | 176784 | 7366 | 289514 | 20680 | 447050 | 24836 | 16787 |
| 0.06–0.20 | 2643549 | 110148 | 55418 | 3958 | 32987 | 1833 | 44429 |
| 0.21–1.00 | 0 | 0 | 2340 | 167 | 5856 | 325 | 157 |
| 1.01–5.00 | 1559490 | 64979 | 3188283 | 227734 | 26389 | 1466 | 99060 |
| 5.01–20.00 | 0 | 0 | 65974 | 4712 | 471240 | 26180 | 9472 |

| **Orogrande Alternative** Artifact Density (items/m$^2$) | *Basin Floor* Total Site Area* | *Basin Floor* Site Area per km$^2$ | *Lower Fan* Total Site Area | *Lower Fan* Site Area per km$^2$ | *All Zones* Site Area per km$^2$ |
|---|---|---|---|---|---|
| ≤0.05 | 260100 | 6021 | 51496 | 4401 | 5697 |
| 0.06–0.20 | 363935 | 8424 | 131786 | 11264 | 8992 |
| 0.21–1.00 | 233897 | 5414 | 108215 | 9249 | 6181 |
| 1.01–5.00 | 22690 | 525 | 5238 | 448 | 510 |

* Site area in m$^2$

4.10) and decline with higher elevation in the NASA and Orogrande Alternatives. Low–to–moderate ceramic diversity site area (1–5 types) exhibits a pattern identical to the lithic diversity data, decreasing with elevation in Stallion and Orogrande and declining as elevation rises in the NASA area.

The greatest overall artifact diversities and high diversity site area are found in the Lower and Middle Fan zones of the NASA Alternative. This fact is somewhat surprising, in light of the impressions gained in the field that most of the larger, more complex sites were located in the Upper Fan zone. Furthermore, both the Stallion and Orogrande Alternatives exhibit the expected pattern of higher diversity site area increasing with elevation which indicates, presumably, a prehistoric preference for locating residential sites at the higher elevations associated with significant topographic features. It should be noted, however, that a similar pattern might result from increased artifact visibility in higher slope areas where the effects of erosion are greater.

The apparent large areal extent of high diversity sites in the two lower NASA zones is in great part a result of the difficulties of site boundary definition encountered in these areas. These problems were a function of the lack of aerial imagery for use during fieldwork and of questions concerning the nature and limits of extensive, low density site areas. Given time, many of these areally extensive sites could have been divided into numerous smaller ones, with the result that the population of sites would be characterized by higher artifact densities and lower diversities. The large sites may well represent areas of highly redundant short–term residential occupation.

From Tables 4.9 and 4.10, it is clear that artifact diversities are considerably higher at NASA Alternative sites than in the other two alternatives, and that the areal extent of these sites is also greater by several orders of magnitude. While some of this can probably be accounted for by the larger site sizes represented, it is presumably also related to differences in site function (i.e., more residential in nature).

Table 4.7. Hearth frequency and environmental zones

| Stallion Alternative | Basin Floor | | Base of Hills | |
|---|---|---|---|---|
| Total Hearths | Total Sites | Sites per km2 | Total Sites | Sites per km2 |
| None | 113 | 2.9 | 87 | 5.8 |
| 1–2 | 0 | 0 | 7 | 0.4 |

| NASA Alternative | Lower Fan | | Middle Fan | | Upper Fan | |
|---|---|---|---|---|---|---|
| Total Hearths | Total Sites | Sites per km2 | Total Sites | Sites per km2 | Total Sites | Sites per km2 |
| None | 96 | 4.0 | 73 | 5.2 | 56 | 3.1 |
| 1–2 | 56 | 2.3 | 28 | 2.0 | 16 | 0.9 |
| 3–5 | 0 | 0 | 6 | 0.4 | 16 | 0.9 |
| 6–10 | 16 | 0.7 | 0 | 0 | 0 | 0 |

| Orogrande Alternative | Basin Floor | | Lower Fan | |
|---|---|---|---|---|
| Total Hearths | Total Sites | Sites per km2 | Total Sites | Sites per km2 |
| None | 56 | 1.3 | 29 | 2.5 |
| 1–2 | 404 | 9.4 | 119 | 10.2 |
| 3–5 | 68 | 1.6 | 15 | 1.3 |
| >5 | 28 | 0.6 | 5 | 0.4 |

Table 4.8. Structures/middens and environmental zones

| Stallion Alternative | Basin Floor | | Base of Hills | |
|---|---|---|---|---|
| Total Hearths | Total Sites | Sites per km2 | Total Sites | Sites per km2 |
| None | 113 | 2.9 | 93 | 6.2 |

| NASA Alternative | Lower Fan | | Middle Fan | | Upper Fan | |
|---|---|---|---|---|---|---|
| Total Hearths | Total Sites | Sites per km2 | Total Sites | Sites per km2 | Total Sites | Sites per km2 |
| None | 160 | 6.7 | 90 | 6.4 | 88 | 4.9 |
| 1–2 | 0 | 0 | 11 | 0.8 | 0 | 0 |
| 3–5 | 8 | 0.3 | 6 | 0.4 | 0 | 0 |

Table 4.9. Lithic artifact diversity and environmental zones

| **Stallion Alternative** Artifact Density (items/m²) | *Basin Floor* Total Site Area* | *Basin Floor* Site Area per km² | *Base of Hills* Total Site Area | *Base of Hills* Site Area per km² | *All Zones* Site Area per km² |
|---|---|---|---|---|---|
| None | 27508 | 705 | 0 | 0 | 501 |
| 3–5 | 22497 | 577 | 20132 | 1341 | 799 |
| 6–10 | 324353 | 8318 | 125596 | 8369 | 8333 |
| 11–20 | 187045 | 4797 | 460212 | 30666 | 12307 |

| **NASA Alternative** Artifact Density (items/m²) | *Lower Fan* Total Site Area* | *Lower Fan* Site Area per km² | *Middle Fan* Total Site Area | *Middle Fan* Site Area per km² | *Upper Fan* Total Site Area | *Upper Fan* Site Area per km² | *All Zones* Site Area per km² |
|---|---|---|---|---|---|---|---|
| 1 | 157080 | 6545 | 0 | 0 | 201 | 11 | 2537 |
| 2 | 0 | 0 | 12931 | 924 | 0 | 0 | 298 |
| 3–5 | 65408 | 2725 | 60476 | 4320 | 10996 | 611 | 2626 |
| 6–10 | 6823799 | 284325 | 61870 | 4419 | 31730 | 1763 | 111999 |
| 11–20 | 5160391 | 215016 | 3835702 | 273979 | 940594 | 52255 | 186783 |

| **Orogrande Alternative** Artifact Density (items/m²) | *Basin Floor* Total Site Area* | *Basin Floor* Site Area per km² | *Lower Fan* Total Site Area | *Lower Fan* Site Area per km² | *All Zones* Site Area per km² |
|---|---|---|---|---|---|
| None | 199019 | 4607 | 54990 | 4700 | 4626 |
| | 121327 | 2808 | 44512 | 3804 | 3007 |
| 2 | 164947 | 3818 | 35786 | 3059 | 3666 |
| 3–5 | 212068 | 4909 | 75053 | 6415 | 5210 |
| 6–10 | 174534 | 4040 | 85521 | 7309 | 4694 |
| 11–20 | 8727 | 202 | 873 | 75 | 177 |

* Site area in m²

Another interesting pattern consists of the higher overall ceramic diversity in the Orogrande area versus the higher lithic diversities in the Stallion Alternative. This pattern may reflect the increased incidence of Paleoindian and Archaic remains in the Stallion area, or may be a function of the sampling methods used in the Border Star 85 survey. Since it is likely that lithic and ceramic types are under-represented in the Border Star 85 data, the pattern is probably real and reflects past behavioral differences in occupation between the two alternatives.

Although there are some differences in the character of the archeological sites between the Orogrande and Stallion Alternatives, these two areas are quite similar with relatively low site area densities in comparison to the NASA area. The latter alternative may be characterized as having much higher site area densities and more complex assemblages of cultural properties. Analyses of environmental variability within the three alternatives revealed that optimum facility placement would be at lower elevations in the Stallion and Orogrande areas. The results of similar analyses (with regard to the NASA Alternative) were inconclusive.

The Orogrande and Stallion Alternatives are roughly equal in terms of the relative densities of various kinds of cultural remains. Orogrande is characterized by greater numbers of small lithic and/or ceramic sites, greater ceramic diversity, and possibly by more abundant fire-using features. The greater diversity of ceramic types in the Orogrande Alternative may also indicate the presence of undetected residential features. The Stallion Alternative differs from Orogrande in the greater overall presence of Archaic and Paleoindian manifestations. Higher lithic type diversities are probably related to the early sites in the Stallion Alternative. Both of these alternatives exhibit a general correlation between increased elevation and site area densities in terms of several measures of site size and complexity. These include both small and medium site densities (sites/km²), and site area densities (m²/km²) for both the higher artifact density and artifact

Table 4.10. Ceramic type diversity and environmental zones

| Stallion Alternative | Basin Floor | | Base of Hills | | All Zones |
|---|---|---|---|---|---|
| Number of Ceramic Types | Total Site Area* | Site Area per km2 | Total Site Area | Site Area per km2 | Site Area per km2 |
| None | 265773 | 6816 | 443239 | 29535 | 13411 |
| 1 | 186489 | 4782 | 129488 | 8628 | 5899 |
| 2 | 109142 | 2799 | 30384 | 2025 | 2574 |
| 3–5 | 0 | 0 | 2829 | 188 | 55 |

| NASA Alternative | Lower Fan | | Middle Fan | | Upper Fan | | All Zones |
|---|---|---|---|---|---|---|---|
| Number of Ceramic Types | Total Site Area* | Site Area per km2 | Total Site Area | Site Area per km2 | Total Site Area | Site Area per km2 | Site Area per km2 |
| None | 107876 | 4495 | 14008 | 1001 | 268921 | 14940 | 6400 |
| 1 | 65345 | 2723 | 11655 | 833 | 135918 | 7551 | 3515 |
| 2 | 232478 | 9687 | 38485 | 2749 | 50266 | 2793 | 5447 |
| 3–5 | 2689209 | 112050 | 49876 | 3563 | 32044 | 1780 | 45040 |
| 6–10 | 3941954 | 164248 | 786844 | 56203 | 25133 | 1396 | 82115 |
| 11–20 | 5169815 | 215409 | 947961 | 67712 | 471240 | 26180 | 112827 |
| 21–50 | 0 | 0 | 2122150 | 151582 | 0 | 0 | 48897 |

| Orogrande Alternative | Basin Floor | | Lower Fan | | All Zones |
|---|---|---|---|---|---|
| Number of Ceramic Types | Total Site Area* | Site Area per km2 | Total Site Area | Site Area per km2 | Site Area per km2 |
| None | 622303 | 14405 | 138779 | 11861 | 13896 |
| 1 | 154471 | 3576 | 61090 | 5221 | 3905 |
| 2 | 68941 | 1596 | 18326 | 1566 | 1590 |
| 3–5 | 26180 | 606 | 78540 | 6713 | 1827 |
| 6–10 | 8727 | 202 | 0 | 0 | 162 |

* Site area in $m^2$

diversity classes. These patterns are taken to indicate that, in the Stallion and Orogrande Alternatives, site size, complexity, and overall extent (areal coverage) are greater in the upper environmental zones. It is also predicted that the probability of encountering subsurface residential features is higher in these zones.

The NASA Alternative represents an entirely different situation, wherein the site densities, sizes, and complexities clearly overshadow those of the other alternatives. Much of the area appears to represent the cumulative record of extensive, recurrent occupation of the alluvial fan area. To some degree, environmental patterning in the NASA Alternative appears to be the reverse of that in the other two alternatives; overall site area and site area densities for high artifact density and diversity appear to decline with increasing elevation on the alluvial fan in the NASA Alternative. Although the data are inconclusive, it appears that the Lower and Middle Fan zones exhibit the greatest evidence for the presence of structural remains. Large structural sites, however, are known to exist in the Upper Fan zone in nearby areas (Duran 1982). Furthermore, Archaic site area densities increase in the Upper Fan (Table 4.4) and contribute to the importance of the zone from a management perspective.

## Statistical Evaluation of the Prediction Model

**Statistical Methods.** Modern computer hardware and software have made it increasingly easy to create and maintain large data bases such as those resulting from the GBFEL–TIE and Border Star 85 surveys, and to generate vast quantities of statistics and examples of apparent statistical patterning. Patterned differences in data are commonly used both for making management-level decisions and to support or refute various interpretive hypotheses.

Table 4.11. Summary of sites, site area, and artifact density projections for GBFEL–TIE facility alternatives

| Alternative | Area ($km^2$) | Total sites | Sites / $km^2$ | Total Site Area* | Site Area per $km^2$ | Site Area per $km^2$ Artifact Density Class: 0.2–1.0 | >1 0–5.0 | >5.0 |
|---|---|---|---|---|---|---|---|---|
| Stallion | 54.0 | 199 | 3.7 | 1184710 | 21940 | 1210 | 0 | 0 |
| NASA | 56.0 | 368 | 6.6 | 17037550 | 304240 | 148 | 99040 | 9120 |
| Orogrande | 54.9 | 724 | 13.2 | 1177360 | 21450 | 6230 | 510 | 0 |

* Site area in $m^2$

Table 4.12. Projected impacts of a hypothetical 10 $km^2$ facility on the three alternatives

| Area | Total Sites | Total Site Area* | Site Area Artifact Density Class: 0.2–1.0 | >1.0–5.0 | >5.0 | Site Area Artifact Diversity Class: ≥6 LTypes** | ≥6 CTypes** |
|---|---|---|---|---|---|---|---|
| Stallion | 37 | 219390 | 12060 | 0 | 0 | 20640 | 0 |
| NASA | 64 | 3042420 | 1480 | 990410 | 91210 | 2987820 | 2438450 |
| Orogrande | 132 | 214450 | 62320 | 5090 | 0 | 49120 | 1590 |

*Site area in $m^2$
**Ltypes=Lithic artifact types; Ctypes=Ceramic artifact types

This prediction model (Tables 4.2–4.12) constitutes a statistical summarization of just such patterning. All too often, however, the users of statistical results based on samples fail to examine critically the assumptions involved and the effects of sample characteristics on the validity or statistical significance of the derived patterns.

In the case of the GBFEL–TIE prediction model, the important question is: "Are the observed interzonal (environmental) and inter-alternative differences in the various site characteristics statistically significant?" Since most of the model is expressed in terms of the average square meters of site area per square kilometers of landscape, the question of significance becomes one of the significance of differences among means (these same means are represented as projections in Tables 4.2–4.12).

Normally, the difference of means or two-sample $t$–test is used to compare means when only two samples are involved (Blalock 1979:224). When multiple levels of a treatment variable (e.g., the three environmental zones in the NASA Alternative or the three alternatives themselves) are involved, analysis of variance (ANOVA) is required (Blalock 1979:336). Two–sample ANOVA and $t$–test results are always identical (assuming equal sample variances) (Blalock 1979:343). Both tests are used to determine whether or not different levels of a categorical treatment variable (e.g., environmental zone) have a significant effect on the mean value of a continuous or measurement variable (e.g., site area per square kilometer).

An assumption critical to both the $t$–test and ANOVA is that of normality; i.e., for each test, it is assumed that the predicted variable (e.g., meters squared of site area per kilometer squared) is normally distributed in any group of sample units to be compared. Nonparametric statistical tests, based on ranks rather than the actual data values, are required when this assumption is violated (Blalock 1979:247–248). The nonparametric equivalents of the $t$–test and ANOVA are the Wilcoxon test [also known as the Mann–Whitney test (Blalock 1979:259–265)] and the Kruskall–Wallis test (Blalock 1979:367–369).

Because of the inherent clustering of archeological materials into sites and the resulting low percentage of site area, the GBFEL–TIE survey data violate the normality

Table 4.13. Stallion Alternative environmental zone nonparametric tests: Site area as a function of zone (basin floor vs base of hills) by chronological period (see Table 4.2)

| Chronological Period | Wilcoxon Test Z | p–value |
|---|---|---|
| Archaic | 2.65 | 0.0021 |
| Lithic Unknown | -0.65 | 0.5149 |
| Multicomp: Formative | -0.57 | 0.5697 |
| Multicomp: PreF/Formative | 1.53 | 0.1263 |
| Historic | -0.57 | 0.5697 |

assumptions severely. For the NASA and Stallion Alternatives, the average percent of empty (zero site area) survey units for the various groupings to be compared is 81% and 85%, respectively. This means that, for any given comparison (e.g., Archaic site area as a function of environmental zone), 80 to 85% of the values used in the computation of the statistics (e.g., the mean) are zero. Thus, while almost all survey units contained some site area, only a few contained Archaic site area. The Orogrande data are less skewed than those for NASA and Stallion (almost all units have some site area), but are nonetheless rarely normal. Fortunately, in the present case, nonparametric methods are equally appropriate (when departures from normality are less severe) and even offer greater power when sample sizes are small (Blalock 1979:265).

Table 4.14. Stallion Alternative environmental zone nonparametric tests: Site area as a function of zone (basin floor vs base of hills) by artifact density class (see Table 4.6)

| Artifact Density | Wilcoxon Test Z | p–value |
|---|---|---|
| ≤0.05 | 0.65 | 0.5153 |
| 0.06–0.20 | 1.49 | 0.1354 |
| 0.21–1.00 | 1.42 | 0.1568 |

The high number of zero–site area sample units, however, leads to a violation of a critical nonparametric assumption: that of no ties (zeros represent tied values, whereas the data are assumed to be continuously distributed). To account for this, Lehman's correction for ties (Lehmann 1975) was used in the Kruskall–Wallis test, and Blalock's correction was used in the Mann–Whitney test (Blalock 1979:263–264). Although the Kolmogorov–Smirnov test is better suited for the two–sample problem when the number of ties is great (Blalock 1979:266), it was not available in the statistical package used [SAS procedure NPAR1WAY (SAS Institute 1982:607–614)]. As a result, the Wilcoxon test was used instead.

Four of the site characteristics analyzed in the prediction model were tested for significant patterning in terms of both environmental zone differences within the separate GBFEL–TIE alternatives and patterning among alternatives. Chronological period, artifact density, lithic artifact diversity, and ceramic artifact diversity were the variables tested for in relation to mean site area density ($m^2/km^2$). Continuous variables such as artifact density were grouped into levels similar to those reported in Tables 4.2–4.10. One nonparametric test was run for each level of each variable to compare environmental zones within each alternative (the environmental component of the model), and to compare the three alternatives (the management component of the model). The Orogrande data were excluded from the inter–alternative test for chronological differences because the Border Star 85 chronological data are not couched in the same terms.

Table 4.15. Stallion Alternative environmental zone nonparametric tests: Site area as a function of zone (basin floor vs base of hills) by lithic diversity class (see Table 4.9)

| Lithic Diversity | Wilcoxon Test Z | p–value |
|---|---|---|
| None | -0.57 | 0.5697 |
| 3–5 | 1.78 | 0.0746 |
| 6–10 | 0.71 | 0.4763 |
| 11–20 | 1.36 | 0.1750 |

Thus, one test was run comparing the three zones in NASA for Archaic site area, one for El Paso site area, and so on. A similar series was run comparing Archaic site area differences among the alternatives. In each test, the sample consists of the data from all of the 0.25 $km^2$ grid units in the zone (or alternative), including zero (no site area) ones. In order to include the Orogrande area data, the Border Star 85 survey data were lumped into 252 units (0.25 $km^2$) representing a 100% sample of all possible units. Thus, the total sample size for the two GBFEL–TIE alternatives is 62 (31 each), while the Orogrande sample size is 252. Within the alternatives, sample sizes for the different environmental zones (survey units in each zone) are 9 and 22 in the Stallion Alternative, 9, 10, and 12 in NASA, and 46 and 192 in Orogrande (Table 4.1).

The results of the Wilcoxon (two levels) and Kruskal–Wallis (three levels) tests are presented in Tables 4.13–4.24 (environmental comparisons) and Tables 4.25–4.28 (alternative omparisons). Each table presents the various

levels of a particular site attribute (time period, site artifact density, lithic or ceramic diversity) to be evaluated in terms of site area as a function of either environmental zone or differences among alternatives. For each site attribute level the resulting Z statistic (Wilcoxon normal approximation) or chi–square statistic (Kruskal–Wallis chi–square approximation) from the nonparametric test is presented along with the associated p–value. P–values less than 0.05 are considered definitely significant, while those between 0.05 and 0.10 are regarded as marginally so.

Table 4.16. Stallion Alternative environmental zone nonparametric tests: Site area as a function of zone (basin floor vs base of hills) by ceramic diversity class (see Table 4.10)

| Ceramic Density | Wilcoxon Test Z | p–value |
|---|---|---|
| None | 1.45 | 0.1464 |
| 1 | 1.53 | 0.1263 |
| 2 | 0.56 | 0.5742 |
| 3–5 | 1.49 | 0.1356 |

Table 4.17. NASA Alternative environmental zone nonparametric tests: Site area as a function of zone (lower/middle/upper fan) by chronological period (see Table 4.3)

| Chronological Period | Kruskal–Wallis Test Z | p–value |
|---|---|---|
| Archaic | 1.89 | 0.3879 |
| Lithic Unknown | 2.62 | 0.2697 |
| Mesilla | 0.48 | 0.7856 |
| El Paso | 2.99 | 0.2243 |
| Multicomp: Formative | 1.26 | 0.5313 |
| Multicomp: PreF/Formative | 1.96 | 0.3746 |

In classical statistics, a p–value represents the probability that the compared samples were drawn from the same population. Alpha, or the significance level of a test, is defined as the probability level below which the analyst feels confident in rejecting the null hypothesis of no significant difference. The value 0.05 (only 5 chances in 100 that the samples are from the same population) is the most commonly used alpha. As Blalock (1979:160–161) has pointed out, there is nothing sacred about 0.05, and somewhat higher levels such a 0.10 are acceptable, especially in cases where researchers wish to avoid Type II errors in which the null hypothesis is retained when in fact the samples are truly different. Thus, in the present case, marginal significance means that a probability between 0.05 and 0.10 is acceptably low and the null hypothesis is unlikely to be true.

Table 4.18. NASA Alternative environmental zone nonparametric tests: Site area as a function of zone (lower/middle/upper fan) by artifact density class (see Table 4.6)

| Artifact Density | Kruskal–Wallis Test Z | p–value |
|---|---|---|
| ≤0.05 | 0.23 | 0.8931 |
| 0.06–0.20 | 0.11 | 0.9454 |
| 0.21–1.00 | 2.28 | 0.3191 |
| 1.01–5.00 | 1.89 | 0.3879 |
| 5.01–20.00 | 1.20 | 0.5493 |

For each table, the p–value indicates the statistical significance of differences among environmental zones (or alternatives) in average site area per square kilometer for a given level of a particular attribute. The values being compared represent the core of the environmental and inter–alternative components of the prediction model and appear in Tables 4.2–4.12 under the heading *Area (meters squared) per kilometers squared.* For example, in Table 4.3, Archaic site area averages 728 $m^2$ per $km^2$ on the Upper Basin Floor and 24,908 $m^2$ per $km^2$ in the Base of Hills zone. Table 4.13 indicates that the probability of this difference is 0.0018 (Wilcoxon Z=2.65), suggesting that the difference is statistically significant. Similarly, Lithic Unknown site area averages 5,382 $m^2$ per $km^2$ on the Upper Basin Floor and only 473 $m^2$ per $km^2$ in the Base of Hills, but this difference is apparently not significant (p=0.5149 in Table 4.13).

Table 4.19. NASA Alternative environmental zone nonparametric tests: Site area as a function of zone (lower/middle/upper fan) by lithic diversity class (see Table 4.9)

| Lithic Diversity | Kruskal–Wallis Test Z | p–value |
|---|---|---|
| 1 | 1.20 | 0.5998 |
| 2 | 2.10 | 0.3499 |
| 3–5 | 1.21 | 0.5460 |
| 6–10 | 2.18 | 0.3355 |
| 11–20 | 4.84 | 0.0891 |

The reader will note that the ceramic–based chronological period classification used in environmental comparisons for Orogrande differs from those in Table 4.2. The Table 4.2 chronological periods were hand–

computed from tabular data and were based on both ceramic and projectile point identifications. Manual tabulations were not possible for the nonparametric tests, given the time constraints of the project, and the available ceramic data were used instead.

Table 4.20. NASA Alternative environmental zone nonparametric tests: Site area as a function of zone (lower/middle/upper fan) by ceramic diversity class (see Table 4.10)

| Ceramic Diversity | Kruskal–Wallis Test Z | p–value |
|---|---|---|
| None | 0.56 | 0.7551 |
| 1 | 0.95 | 0.6225 |
| 2 | 0.08 | 0.9612 |
| 3–5 | 0.92 | 0.6298 |
| 6–10 | 2.99 | 0.2243 |
| 11–20 | 1.62 | 0.4439 |
| 21–50 | 4.34 | 0.1142 |

**The Environmental Model.** Tables 4.13–4.24 contain the nonparametric test results for environmental zone comparisons within each project alternative. Inspection of the p–values for the various tests indicates that almost none of the environmental patterning suggested by the prediction model is statistically significant. Exceptions are the relationship between Archaic site area and environmental zone in the Stallion Alternative ($p=0.0018$) and that of site area versus zone for Stallion sites with 3–5 lithic types present ($p=0.0746$) and NASA sites with 11–20 lithic types present ($p=0.0891$). The latter two are only marginally significant ($0.10>p>0.05$).

Several possible factors may be involved in the general failure of these tests to reveal statistically significant differences, even where the average figures in Tables 4.2–4.10 appear to differ greatly. These factors include high sample variance, high numbers of tied ranks, improper model specification (poor or erroneous measures), and small samples.

*High sample variance:* The variances for the environmental zone and alternative samples are generally very high. These high variances—as discussed in the introduction to this chapter—reflect the aggregate nature of cultural landscapes in general: typical landscapes are characterized by large areas of low density with intervening loci of high density usually recorded as sites. This fact results in skewed distributions and high numbers of sample grids with little or no site area of a particular kind (e.g., Archaic). High variance results in considerable overlap among compared distributions and a consequent reduction in the power of statistical tests (Blalock 1979:250).

*High numbers of tied ranks:* This problem results from the many empty sample grids (average 80–85%) in most comparisons. Although corrections for tied data were included in the tests, the large numbers involved may have severely hampered the robustness of the tests (Dr. Ron Schrader, UNM Math Dept., personal communication 1987).

Table 4.21. Orogrande Alternative environmental zone nonparametric tests: Site area as a function of zone (basin floor vs lower fan) by ceramic period (see Table 4.4)

| Chronological Period | Wilcoxon Test Z | p–value |
|---|---|---|
| Unknown Formative | -0.49 | 0.6231 |
| Mesilla | -1.26 | 0.2044 |
| El Paso | 0.60 | 1.0000 |
| Aceramic | 0.01 | 0.9898 |

*Improper model specification, poor or erroneous measures:* Improper model specification, i.e., a relationship exists between the variables in the test, of course leads to retention of the null hypothesis. Poor or erroneous measurement results from the use of improper variables (e.g., use of the wrong environmental zones), or poor data collection (e.g., misidentified site boundaries), and can severely weaken target patterning.

Table 4.22. Orogrande Alternative environmental zone nonparametric tests: Site area as a function of zone (basin floor vs lower fan) by artifact density class (see Table 4.6)

| Artifact Density | Wilcoxon Test Z | p–value |
|---|---|---|
| ≤0.05 | 1.34 | 0.1795 |
| 0.06–0.20 | 0.94 | 0.3471 |
| 0.21–1.00 | -0.32 | 0.7477 |
| 1.01–5.00 | 0.70 | 0.9445 |

*Small samples:* As noted earlier, small sample sizes reduce the power of statistical tests. Because survey units are the cases or observations in the nonparametric tests used here, environmental zone sample sizes for the GBFEL–TIE survey data average about 10 with the largest being 22 (Table 4.1). Sample sizes for the Border Star 85 survey data (50, 200) are much larger due to the 100% coverage. The effects of non–normality (which are severe in the present case) are reduced when sample sizes exceed ca. 50 (Blalock 1979:227), and thus the Border Star 85 data may be less affected by the extreme

skewness in the grid data. The sample sizes of the GBFEL-TIE survey data are well below this threshold, however, and it is not surprising that statistically significant results are rare for the NASA and Stallion Alternatives. The complete lack of significant results for Orogrande, on the other hand, may be real.

Table 4.23. Orogrande Alternative environmental zone non-parametric test: Site area as a function of zone (basin floor vs lower fan) by lithic diversity class (see Table 4.9)

| Lithic Diversity | Wilcoxon Test Z | p-value |
|---|---|---|
| None | 1.22 | 0.2200 |
| 1 | 0.37 | 0.7149 |
| 2 | -0.44 | 0.6564 |
| 3–5 | -0.13 | 0.8938 |
| 6–10 | 0.28 | 0.7778 |

The scope of this document does not allow for a detailed evaluation of the accuracy of either the survey data used or the environmental zone identifications. Therefore the utility of the variables used and the appropriateness of the specified environmental models must be assumed. Furthermore, the nature of the sample data (especially that from NASA and Stallion) together with their effect on and the utility of the statistical tests used, can and should be questioned.

Table 4.24. Orogrande Alternative environmental zone nonparametric tests: Site area as a function of zone (basin floor vs lower fan) by ceramic diversity class (see Table 4.10)

| Ceramic Density | Wilcoxon Test Z | p-value |
|---|---|---|
| None | -0.55 | 0.5811 |
| 1 | 0.72 | 0.4728 |
| 2 | -0.72 | 0.4718 |
| 3–5 | 1.09 | 0.2748 |

Nonparametric tests were used instead of their parametric counterparts in order to avoid the consequences of extreme departures from normality. Unfortunately, the same phenomenon responsible for non-normality (aggregation in the target data) resulted in very high numbers of tied ranks in the NASA and Stallion data (zero-site area grids), perhaps reducing the power of the tests below acceptable levels. The effect of ties on the nonparametric results is most severe for the two sample survey alternatives, NASA and Stallion. Thus, even the nonparametric tests may be inappropriate in these cases. The Orogrande data, however, exhibited far fewer zero grids, either due to greater ubiquity of cultural resources or to the larger samples. Both the larger sample sizes and the fewer number of ties suggest that the statistical results for Orogrande may well be valid.

These considerations suggest that the NASA and Stallion sample data may not be well-suited to the kinds of predictive modelling or projection attempted here. Perhaps further research in the statistical literature would reveal more robust tests which are resistant to the effects of the highly skewed distributions which result from cluster sampling of aggregated data, however time constraints prevented such a search. Conversely, it might be recommended that the standard 10–15% sample survey methodologies be carefully reconsidered in light of the problems created by the use of low sampling fractions, large grid sizes, and aggregated target data. These problems principally involve the effects of high variances, low precision, small sample size (n), and tied ranks (in the case of nonparametric tests) on the utility and power of various statistical tests used to evaluate the validity of apparent patterning in survey data. Given the results presented here, along with the recommendations of Nance (1981) and Plog (1976), it is suggested that future sample survey designs be substantially revised in favor of higher sampling fractions and/or smaller sample units, both of which would serve to increase overall sample size (n). Larger sampling fractions would also increase precision.

Table 4.25. GBFEL-TIE alternative site area nonparametric test results: Chronological periods for NASA and Stallion Alternatives (see Tables 4.2–4.4)

| Chronological Period | Wilcoxon Test Z | p-value |
|---|---|---|
| Archaic | -0.30 | 0.7673 |
| Lithic Unknown | 1.92 | 0.0550 |
| Mesilla | -2.03 | 0.0420 |
| El Paso | -2.77 | 0.0057 |
| Multicomp: Formative | -2.96 | 0.0031 |
| Multicomp: PreF/Formative | -1.92 | 0.0546 |
| Historic | 0.97 | 0.3332 |

In an attempt to find another nonparametric test for evaluating the environmental component of the model, the chi-square test was used to examine the relationships among environmental zones and site time periods for the site count data in Tables 4.2, 4.3, and 4.4. Actual site counts rather than the projected totals were used since the latter would artificially inflate the sample size (n). Although the chi-square test is a true nonparametric test (Thomas 1986:283), it is particularly sensitive to small sample sizes (Blalock 1979:282). A drawback, from the standpoint of this particular model, is that site counts

rather than site area must be used. As noted earlier, site counts are of less value than site area estimates for assessing potential impacts.

Table 4.26. GBFEL–TIE alternative site area nonparametric test results: Artifact density classes (see Table 4.6)

| Artifact Density | Kruskal–Wallis Test Z | p–value |
|---|---|---|
| ≤0.05 | 0.06 | 0.9696 |
| 0.06–0.20 | 2.68 | 0.2621 |
| 0.21–1.00 | 12.46 | 0.0020 |
| 1.01–5.00 | 15.07 | 0.0005 |
| 5.01–20.00 | 17.21 | 0.0002 |

Tables 4.29–4.31 present the results of the chi-square tests comparing site time periods and environmental zones for the Stallion, NASA. and Orogrande Alternatives, respectively. (Particularly rare site types, such as Historic and Paleoindian, have been left out in order to increase the potential for meaningful results.) Cell chi-square values (the contribution of each cell to the total chi-square statistic) are presented along with site counts and the resulting chi-square and probability. Cell chi-square values are useful in determining which particular cell counts and category combinations are most responsible for a significant result (Blalock 1979:297).

Table 4.27. GBFEL–TIE alternative site area nonparametric test results: Lithic diversity classes (see Table 4.9)

| Lithic Diversity | Kruskal–Wallis Test Z | p–value |
|---|---|---|
| None | 33.50 | 0.0001 |
| 1 | 20.71 | 0.0001 |
| 2 | 19.38 | 0.0001 |
| 3–5 | 2.22 | 0.3293 |
| 6–10 | 28.96 | 0.0001 |
| 11–20 | 101.79 | 0.0001 |

Again, the small sample sizes for the Stallion and NASA Alternatives appear to have affected the power of the tests. The sensitivity of the chi-square test to small sample sizes is expressed in a rule that states that, in general, no more than 20% of the cells can have expected counts of fewer than five (Blalock 1979:291). In cases where this limit is exceeded, no cell may have an expected count of fewer than two (Thomas 1986:298). The chi-square tables for both these alternatives violate both these rules. Thus the results, especially the apparently significant one for the Stallion data (p=0.012), violate both rules.

Another factor that may affect the results for the NASA Alternative is the complexity of the table. Blalock (1979:292) suggests that the only way to increase expected counts is to combine categories, however, such a strategy would obviate the purpose of the tests. Yet another way to simplify the test is to subdivide the chi-square table into parts (Blalock 1979:297–299). But this approach is also subject to the problems of low expected counts when samples sizes are small.

Table 4.28. GBFEL–TIE Alternative nonparametric test results: Ceramic diversity classes (see Table 4.10)

| Ceramic Diversity | Kruskal–Wallis Test Z | p–value |
|---|---|---|
| None | 14.58 | 0.0007 |
| 1 | 1.78 | 0.4115 |
| 2 | 3.19 | 0.2033 |
| 3–5 | 18.28 | 0.0001 |
| 6–10 | 55.59 | 0.0001 |
| 11–20 | 74.69 | 0.0001 |
| 21–50 | 18.32 | 0.0001 |

For the Stallion Alternative, the differences between Archaic and Lithic Unknown sites are extreme, stimulating, and probably real. Unfortunately, the small sample sizes involved preclude conclusive results.

The effect of larger sample sizes on the power of the chi-square test is quite evident in the results for the Orogrande Alternative. From Table 4.31 it is clear that significant patterning in site counts exists. Based on the high cell chi-square values, the strongest patterning is that for Mesilla sites (Lower Fan), Unknown sites (Basin Floor), and possibly Archaic sites (Basin Floor).

In the long run, although in-field observations made during both the GBFEL-TIE and Border Star 85 surveys tend to confirm at least some of the apparent patterning in the model presented in Tables 4.2–4.10, the sampling methods used, together with the aggregate nature of the surface archeological record in all three alternatives, preclude statistical confirmation of these patterns.

**Inter-alternative Comparisons.** In contrast to the evaluation of the environmental component of the model, many of the nonparametric tests comparing the three alternatives were statistically significant at the 0.05 level (see Tables 4.25–4.28). Note that only the NASA and Stallion Alternatives could be compared statistically in terms of site area density (by time period), owing to differences in the coded chronological data for the Border Star 85 survey results. As in the case of the environmen-

tal comparisons, some nonsignificant results may be due to small samples and high variances, even though the NASA and Stallion overall sample sizes are each 31.

Table 4.25 shows the Wilcoxon test results comparing the NASA and Stallion Alternatives in terms of site area density for each of several chronological periods. The two alternatives differ significantly ($p \leq$ ca. 0.05) with respect to all but two time periods: Archaic and Historic. In fact, Archaic site area is almost identical in NASA and Stallion (cf. Tables 4.3 and 4.4) and the lack of a significant difference is not surprising. The absence of a difference in terms of historic sites can be explained by their general rarity.

The results for the other time periods confirm the site area differences presented in Tables 4.3 and 4.4, which indicate far greater site area in the NASA Alternative than in Stallion for all but Lithic Unknown sites. Interestingly, the greater area for Lithic Unknown sites in the Stallion Alternative is also statistically significant. Gen–

Table 4.29. Stallion Alternative sites: Chi–square analysis of chronological period by environmental zone

| Environmental Zone | Archaic | Chronological Period<br>Lithic Unknown | Mutlicomp Formative | Mutlicomp Pre/Form | All Periods |
|---|---|---|---|---|---|
| **Basin Floor** | | | | | |
| Frequency | 1 | 10 | 1 | 3 | 15 |
| Cell Chi–square | 1.90 | 2.32 | 0.45 | 0.59 | |
| **Base of Hills** | | | | | |
| Frequency | 6 | 2 | 0 | 6 | 14 |
| Cell Chi–square | 2.03 | 2.48 | 0.48 | 0.63 | |
| **All Zones** | | | | | |
| Frequency | 7 | 12 | 1 | 9 | 29 |

| *Statistic* | *DF* | *Value* | *Prob* |
|---|---|---|---|
| Chi–Square | 3 | 10.88 | 0.012 |

WARNING: 75% of the cells have expected counts fewer than 5. Chi–Square may not be a valid test.

Table 4.30. NASA Alternative sites: Chi–square analysis of chronological period by environmental zone

| Environmental Zone | Archaic | Lithic Unknown | Chronological Period<br>Mesilla Phase | El Paso Phase | Mutlicomp Formative | Mutlicomp Pre/Form | All Periods |
|---|---|---|---|---|---|---|---|
| **Lower Fan** | | | | | | | |
| Frequency | 4 | 1 | 1 | 3 | 6 | 6 | 21 |
| Cell Chi–square | 0.15 | 0.05 | 0.25 | 0.03 | 0.01 | 0.01 | |
| **Middle Fan** | | | | | | | |
| Frequency | 1 | 0 | 2 | 4 | 6 | 6 | 19 |
| Cell Chi–square | 1.32 | 1.12 | 0.17 | 0.35 | 0.12 | C.12 | |
| **Upper Fan** | | | | | | | |
| Frequency | 3 | 2 | 1 | 1 | 2 | 2 | 11 |
| Cell Chi–square | 0.94 | 2.83 | 0.02 | 0.31 | 0.34 | 0.34 | |
| **All Zones** | | | | | | | |
| Frequency | 8 | 3 | 4 | 8 | 14 | 14 | 51 |

| *Statistic* | *DF* | *Value* | *Prob* |
|---|---|---|---|
| Chi–Square | 10 | 8.47 | 0.583 |

WARNING: 78% of the cells have expected counts fewer than 5. Chi–Square may not be a valid test

Table 4.31. Orogrande Alternative sites: Chi-square analysis of chronological period by environmental zone

| Environmental Zone | Archaic | Lithic Unknown | Chronological Period Mesilla Phase | El Paso Phase | Unknown Formative | Unknown | All Periods |
|---|---|---|---|---|---|---|---|
| **Basin Floor** | | | | | | | |
| Frequency | 31 | 313 | 6 | 27 | 166 | 34 | 577 |
| Cell Chi-square | 0.33 | 0.16 | 2.79 | 0.01 | 0.19 | 2.09 | |
| **Lower Fan** | | | | | | | |
| Frequency | 13 | 79 | 9 | 7 | 54 | 0 | 162 |
| Cell Chi-square | 1.17 | 0.56 | 9.92 | 0.03 | 0.69 | 7.45 | |
| **All Zones** | | | | | | | |
| Frequency | 44 | 392 | 15 | 34 | 220 | 34 | 739 |

| *Statistic* | *DF* | *Value* | *Prob* |
|---|---|---|---|
| Chi-Square | 5 | 25.38 | 0.000 |

erally, the results indicate that the model is correct in indicating markedly higher impact on all site types in the NASA area, with the exception of Lithic Unknown. Impacts on the latter type would be on the order of ten times greater in the Stallion Alternative.

The results of Kruskal-Wallis tests comparing all three alternatives in terms of site artifact density appear in Table 4.26. The model (Table 4.6) suggests that the NASA Alternative contains greater site area for all site artifact density classes except the 0.21–1.00 artifacts/m$^2$ class which is dominated by Orogrande. In the two lowest and two highest classes, the Orogrande and Stallion Alternatives are more nearly equal and NASA stands out. The nonparametric tests, however, confirm only the differences in the middle and two highest classes. As discussed earlier, the failure of the tests to discriminate among the three alternatives may reflect small sample sizes. Nonetheless, the tests do confirm the clear difference between NASA and the other two alternatives in terms of high artifact density site area. Thus, potential impact at NASA is much greater.

Table 4.27 shows statistically significant Kruskal-Wallis results for the inter-alternative comparisons of lithic type diversity with one exception, the 3–5 artifact types category. Again, NASA contains the greatest site area for the most part, especially in the high diversity classes (≥ 6 types present). The Orogrande Alternative has the most site area for the low diversity classes (0–5 types). This fact presumably reflects the different site sampling methods used on the Border Star 85 survey. The Orogrande Alternative also exhibits the least site area for the higher diversity classes (≥ 6 types), with Stallion falling in between NASA and Orogrande. The NASA Alternative stands out in the higher diversity classes with far more site area, thus indicating greater potential impact.

The inter-alternative ceramic diversity Kruskal-Wallis test results are presented in Table 4.28. Significant patterning is indicated for all but the Ceramic Types Classes 1 and 2. For ceramic diversities of three or greater, the NASA Alternative contains the greatest site area (Table 4.10); the p-values in Table 4.28 indicate that these differences are statistically significant. On the other hand, the Stallion and Orogrande Alternatives appear to differ little. Again, potential impact in the NASA Alternative appears markedly higher.

Overall, the results of the statistical evaluation of the model suggest that, although most of the environmental portion of the prediction model cannot be confirmed, the three GBFEL-TIE alternatives do differ. In spite of the excessive variances contributed by large sample units and small sample sizes, the NASA Alternative appears different from the other two. Although in multiple comparisons, the Kruskal-Wallis test cannot identify which category is most responsible for significant results, the data in Tables 4.2–4.12 clearly indicate that, in most cases, the NASA Alternative differs more from the Stallion and Orogrande Alternatives than the latter do from each other.

## Projected Impacts

The environmental component of the model suggests that placing the GBFEL-TIE facility at lower elevations in either the Stallion or Orogrande areas will reduce the impact on cultural resources. Although the reverse appears to be true for the NASA Alternative, the Middle Fan zone is generally the most complex of the three zones defined. It is thus more difficult to predict the best general location for a facility in the NASA area.

Tables 4.11 and 4.12 summarize the results of the prediction model by comparing the three alternatives without

reference to the environmental strata. Table 4.11 contains projections for total sites, total site area, and site and site area densities per square kilometer for three classes of artifact density, for each of the three alternatives. Projections are for the entire area of each alternative. Table 4.12 contains the projected impacts of the hypothetical 2 x 5 km facility for each alternative, based on the areal averages in Table 4.11.

In addition, Table 4.12 presents site area density statistics ($m^2/km^2$) for site artifact densities of 0.2–1 artifacts/$m^2$ (moderate density), 1.01–5 artifacts/$m^2$ (high) and >5.0 artifacts/$m^2$ (very high). This provides a framework for assessing the potential data recovery efforts required. Similar site area figures are provided for sites with high lithic and ceramic diversities (≥6 types present).

From these figures, it is clear that the NASA area differs markedly from the Stallion and Orogrande Alternatives. Using the hypothetical 2 x 5 km facility, we can project the relative effects on cultural resources of the three alternatives (Table 4.12), assuming total destruction within the hypothetical 10 $km^2$ construction area.

The data in Table 4.12 indicate that, from the perspective of potential impact and anticipated data recovery requirements, the NASA Alternative represents tremendous potential destruction and a monumental data recovery effort—over two million square meters of site area (200 ha), including over one million square meters (100 ha) of high density site area and 200,000 $m^2$ (20 ha) of high diversity site area.

The Stallion and Orogrande Alternatives are roughly equivalent in terms of potential impact, although impact figures for Stallion appear to be the lowest overall. The Orogrande area has more high diversity site area, more sites, and more high density site area and may have more fire–using features than does the Stallion Alternative. It should be noted, too, that the artifact diversity figures for Orogrande are artificially low due to the use of nonsite sampling procedures. The Stallion Alternative, on the other hand, appears to have fewer sites; however, it contains a higher incidence of Archaic and Multicomponent site area (Tables 4.2 and 4.3). The higher numbers of sites in the Orogrande area are a surprise considering the expectation that the Border Star 85 survey underestimated site numbers, but may indicate that cultural resources are scattered and perhaps smaller in areal extent.

In considering the data in Tables 4.11 and 4.12 it should be remembered that the site area estimates for Orogrande are unadjusted and probably underestimate the true site area by 20–50%. This may be somewhat offset by the abundance of small sites whose areas were overestimated in the process of translating the TRU data from Phase I of Border Star 85 into estimates of site size. For purposes of comparison, however, it may be safest to assume that there is more site area in the Orogrande Alternative than indicated by the data presented here, most of which is in the form of low density Lithic Unknown sites.

In conclusion, the NASA Alternative is vastly and obviously different from the other two alternatives, and placement of the GBFEL–TIE facility in the NASA area will result in significantly greater impacts on cultural resources and correspondingly higher mitigation costs.

Chapter 5

# EVALUATION OF SIGNIFICANCE AND RECOMMENDATIONS

## Evaluation of Cultural Resources

The Stallion, NASA, and Orogrande GBFEL–TIE alternatives differ significantly in terms of the basic nature, size, and number of cultural resources as seen from reconnaissance survey. Although the available data are thought to be insufficient for formal determinations of significance on an individual basis, the importance of these resources as a group is considered to be high, for several reasons. First, because significance is defined largely by what is not known about the past rather than what is known, the present low level of knowledge within the Jornada region dictates that significance be defined broadly. Many very basic questions concerning chronology and identification remain unanswered in this area of the southwest, mainly due to the lack of excavation data. We know next to nothing about Preformative stage adaptations and cannot reliably even identify components affiliated with this period. Similarly, the dating and function of small Formative stage sites remain problematic, a fact that has adversely affected virtually all settlement pattern studies within the Jornada region. These are problems that can only be solved through more intensive forms of data collection (e.g., excavation).

The potential for addressing these and other questions is high for each of the GBFEL–TIE alternatives. The Stallion area contains information believed critical to understanding both Paleoindian and Archaic adaptations and which may allow some advancement in the current low level of chronological control. The NASA Alternative also offers an opportunity to study Archaic period adaptations but, because of the extremely high site density, it can also be seen as a unique laboratory for studying late Formative subsistence and settlement. Cultural resources in the Orogrande area may provide an ideal research situation for solving the continuing problem of the functional role and chronological placement of small sites in the Tularosa Basin and Hueco Bolson. In sum, there is something crucial to be learned in each of the GBFEL–TIE alternatives and this fact defines the significance of their cultural resources.

In our opinion, all three alternatives contain a considerable number of sites which are individually eligible, on the basis of their data content, for inclusion to the National Register of Historic Properties under criterion "d" of Section 106 of the National Historic Preservation Act of 1966, as amended. However, the NASA Alternative warrants considerably more attention in this regard. The cultural properties within this area are thought to have significance at the national as well as regional level and should form the basis for a major thematic or district nomination to the National Register. In comparison with formally and informally known sites along the Jornada Slope, such as Cottonwood Springs, Indian Hill, the Bruton Bead site, and Indian Tank, most of the recorded NASA properties are better preserved with only minor amounts of vandalism evident. A major percentage of the archeological sites suspected to be present in the NASA Alternative are believed eligible for inclusion in the National Register, but their collective significance far exceeds the sum of their importance as individual properties.

## Recommendations

Our analyses have shown that the three GBFEL–TIE alternatives differ considerably in both the quantity and nature of cultural remains present. In each case, the resources present can contribute significantly to our understanding of prehistoric settlement and subsistence in the Jornada Mogollon region. Obviously, the final choice of which alternative to use and the specific placement of the GBFEL–TIE facility within the chosen area will have a considerable effect on the kinds and extent of data recovery strategies required to mitigate the adverse impacts of facility construction and use. Since the specific nature of the construction activities is unknown, it has been assumed for purposes of comparison that total destruction will result in a 2 x 5 km area; that is, 10 $km^2$ of land surface will require some form of archeological attention.

In addition, potential indirect impacts on neighboring cultural resources should be taken into account in considering possible treatments. The NASA area in particular contains at least two large structural sites which are now relatively inaccessible to pothunters. This situation would change radically if a large facility were constructed nearby.

Based on the results of the model discussed in Chapter 4, it is recommended that future work on any of the alternative sites should include the following:

1) An intensive (i.e., 100%) archeological survey of the facility area, including all construction loci, access roads, and a surrounding buffer zone (to assess potential indirect impacts). The purpose of such a survey would be to identify sites and/or site areas for evaluation and possible excavation.

2) Implementation of geomorphological/environmental study using remote sensing methods. Such a study should provide information critical to understanding geomorphological dynamics in the area and their effects on the relationship between surface and subsurface archeological remains.

3) Testing and recording of all sites and/or site areas for the purpose of evaluating the nature and extent of cultural deposits present and their scientific potential.

4) Development of a data recovery plan, using input from the first two actions plus the results of the GBFEL–TIE sample survey and any other previous archeological work in the area. Such a plan should address both methodological and behavioral questions.

5) Excavation and/or intensive surface recording of all or a substantial portion of the cultural remains to be destroyed by construction activities. Resources subject to possible indirect impacts should be considered in the choice of mitigation samples.

Although the original Border Star 85 survey represents 100% coverage of the Orogrande Alternative, it is recommended that, if chosen, the facility location be resurveyed because of questions concerning the limitation of site content data derived from the transects (Doleman 1986). In the event that either the NASA or Stallion alternatives is chosen, some resurvey of the units surveyed during the GBFEL–TIE project may be required in order to relocate and plot the sites on aerial photos and reassess the accuracy of site boundaries.

Both the Border Star 85 and GBFEL–TIE sample survey projects have raised important questions concerning the effects of geomorphic processes on cultural remains in all three alternatives. The question of whether large areas, such as those encountered in the NASA Alternative, should be considered as many small sites or as large diffuse ones is crucial to archeological research in Jornada region and much of the desert Southwest. These questions are particularly important given the current lack of knowledge concerning the conten of large areas of eolian matrix with occasional artifact–bearing blowouts. It is suggested that the development of a geomorphological model would contribute greatly to answering these questions. A testing phase prior to excavation would provide information critical to the choice of areas for mitigative data recovery and the development of such a model.

## Preliminary Mitigation Effort Estimates

Table 5.1 shows the relative cost estimates in terms of person days and person years for the fieldwork portion of two of the recommended actions described above: intensive survey and intensive surface recording. Figure 5.1 shows the resulting differences graphically and indicates clearly the similarity of the Stallion and Orogrande alternatives and the vast difference between them and the NASA alternative.

Table 5.1. Comparison of estimated field effort for inventory and controlled surface collection for hypothetical 10 km² facility

| Alternative | Inventory* | Collection* | Total* | Total** |
|---|---|---|---|---|
| Stallion | 83 | 219 | 302 | 1.16 |
| NASA | 200 | 3042 | 3242 | 12.47 |
| Orogrande | 125 | 214 | 339 | 1.30 |

* person days
** person years

The effort figures in Table 5.1 were derived from two sources. First, the estimates for inventory survey for the NASA and Stallion Alternatives were derived directly from the GBFEL–TIE survey rates which appear in Table 2.2 (Stallion=12 ha per person day; NASA=5 ha per person day). Inventory survey rates for the Orogrande Alternative, were estimated to be 8 ha per person day, a figure intermediate between those of the other two. This was done because the number of sites in the Orogrande Alternative is much higher than estimates for Stallion, although site area estimates (Table 4.11) are almost identical.

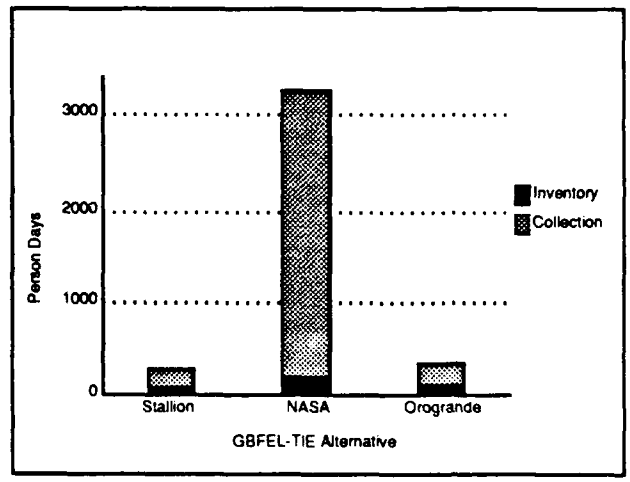



Figure 5.1. Effort comparisons for inventory and controlled surface collection for a hypothetical 10 km² facility

Second, the figures in Table 5.1 for controlled surface collection are based on the Border Star 85, Phase II effort statistics which average about 0.1 ha per person day at artifact densities up to 10 items/m². Without the results of a testing phase, estimation of manpower requirements for mitigative measures is practically an impossible task. For comparative purposes, however, it has been estimated that excavation of a 20% sample of the predicted site area

in the three alternatives—assuming an average depth of 0.2 m and an average rate of 0.5 $m^3$ per person day—would require the following effort:

| | | |
|---|---|---|
| Stallion | 68.7 | person years |
| NASA | 936.1 | person years |
| Orogrande | 66.0 | person years |

The rates of excavation used in these calculations may be too low and the overall amount of site area that would actually require excavation is undoubtedly overestimated, but the predicted *differences* among thc three alternatives are believed accurate. The implications for placement of the GBFEL–TIE facility remain the same no matter what figures are used: the NASA Alternative would require almost seven times the effort needed for treatment of the cultural resources within the Stallion and the Orogrande Alternatives combined.

Appendix 1

# GBFEL-TIE SCOPE OF WORK

SCOPE OF WORK
GB-FEL-TIE CULTURAL RESOURCES SURVEY
DELIVERY ORDER NO. 4

1. GENERAL

A cultural resources reconnaissance survey is required for input into an Environmental Assessment and initial site selection for GB-FEL-TIE at White Sands Missile Range, New Mexico. Additional investigations may be required at a later time.

2. SCOPE

The contractor shall cause to be surveyed 15% of two - 2 by 10 mile areas at WSMR (15% of 40 square miles total=survey area of 6 square miles, or 3840 acres). Precise areas will be specified by the Government as soon as they are identified. Both 2 by 10 mile units will be close to gravel roads. A specific research design will be required prior to starting survey efforts, agreeable to the New Mexico SHPO and the Corps of Engineers, Fort Worth District (CE). General features of the design shall include:

A. Intensive survey effort equal to 15-25 meter spacing between transect tracks.

B. Ramdomized design of survey units in at least 0.5 km square quadrats chosen so that all areas of the 2 by 10 mile units are examined.

C. Isolated artifact recording.

D. Prediction model for assessing construction impact in various areas of each 2x10 mi. unit, with appropriate data collection to use the model.

E. Research questions and hypotheses designed to extend the Border Star 85 survey questions (along with others that may be applicable). A copy of the BS-85 research design and scope of work is supplied.

F. Preparation for and curation of all artifacts in a New Mexico repository approved by the CE and New Mexico SHPO.

G. All sites shall be recorded in the ARMS system.

The survey shall be conducted in accordance with the Research Design. 100 copies of the final report will be required, and 8 copies of the draft report.

An Environmental Assessment is being prepared which will require input on cultural resources. The contractor shall prepare a short section suitable for inclusion in the assessment on cultural resources (approximately 5 double spaced pages) and another on evaluation of cultural resource impacts by the separate alternatives. The Government will furnish information as it is available.

The contractor's PI shall attend an introductory session at WSMR in mid-May, 1986. Consultation with the SHPO may be required at the same or later time.

3. SCHEDULE

Research Design — May 16, 1986

Preliminary Results (site information, maps, and prediction results) and Environmental Assessment — July 15,1986

Draft Final Report — September 19,1986

Final Report — 45 days from reciept of Government comments.

4. OTHER

Contractor is cautioned that security is necessary at WSMR and range access badges will be required. No foreign personnel will be allowed on crews. Work will require clearance, perhaps on a daily basis, from Range Control, and down time must be allowed for. Weekend work is less likely to be affected by range firings. Highway 70 is closed approximately twice a month for missile firings. No on-base facilities are available. Crews must be briefed by WSMR explosive experts who may be required to accompany crews. Radios may not be used on WSMR, and cameras are not allowed. The Government will periodically schedule a photographer to accompany the contractor. The Government shall furnish Color IR photographic prints of the areas.

Appendix 2

# SURVEY FORMS, FIELD CODING GUIDES, AND SUMMARY SITE DESCRIPTIONS

*THE GBFEL-TIE SAMPLE SURVEY*

```
+----------------------------+
| WSMR-86  MASTER SITE FORM |
+----------------------------+
```

{See back for site narrative & triangulations}

------------------------------SITE DATA------------------------------

SURVEY UNIT:_____ SITE NO: __________

DATE: MONTH ______ DAY ______ RECORDER: ______

SITE TYPE: _______ SITE CONDITION: _______

TOPOGRAPHIC SETTING: _____ VEGETATION: _____

ELEVATION: ________ UTMS: ___________ E _____________ N

| COMPONENTS PRESENT: | PALEO | ARCHAIC | MESILLA | DONA ANA | EL PASO | OTHER FORMATIVE | HISTORIC |
|---|---|---|---|---|---|---|---|
| | ____ | ____ | ____ | ____ | ____ | ____ | ____ |

SITE DIMENSIONS (m): LENGTH _______ WIDTH ________

TOTAL PROVS: ________ TOTAL SAMPLES: __________

CREW CHIEF CHECKLIST: MAPs____ COLL'Ns____ PCFs____ ASFs____

------------------------------PROVENIENCE DATA------------------------------

PROV NO.:_____

| PROVENIENCE STATS | | | | | SAMPLES | | | |
|---|---|---|---|---|---|---|---|---|
| EST DEPTH | DIMENSIONS LENGTH | WIDTH | FLAGGING FRACTION | FLAG COUNT | FLAGS SAMPLED | RARE? | DISCRETE LEN | x WID |
| ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |

| PROVENIENCE ATTRIBUTES & COUNTS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SCATTERS LITHIC | CERAMIC | FCR | TOT FCR | HEARTHS /STAINS | MIDDENS | PIT STRS | SURF UNITS | OTHER PREHIST | HISTORIC STRS | TRASH |
| ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |

PROV NO.:_____

| PROVENIENCE STATS | | | | | SAMPLES | | | |
|---|---|---|---|---|---|---|---|---|
| EST DEPTH | DIMENSIONS LENGTH | WIDTH | FLAGGING FRACTION | FLAG COUNT | FLAGS SAMPLED | RARE? | DISCRETE LEN | x WID |
| ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |

| PROVENIENCE ATTRIBUTES & COUNTS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SCATTERS LITHIC | CERAMIC | FCR | TOT FCR | HEARTHS /STAINS | MIDDENS | PIT STRS | SURF UNITS | OTHER PREHIST | HISTORIC STRS | TRASH |
| ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |

## NARRATIVE INFORMATION

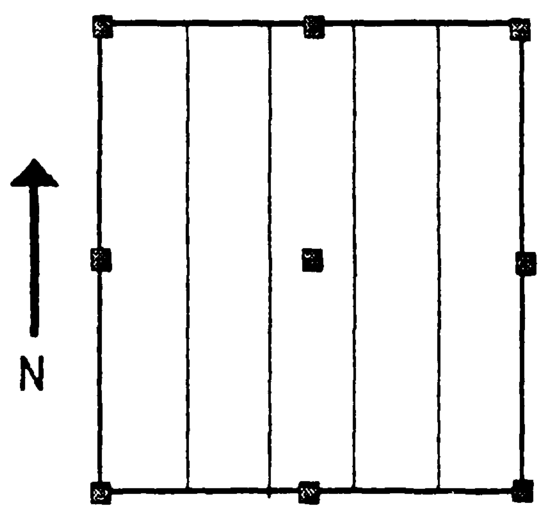
General site description: ______________________________

Location and Access: ______________________________

Temporal/Cultural components: ______________________________

Boundaries: ______________________________

Site condition/Preservation: ______________________________




### SITE LOCATION DATA

# WSMR-86 SURVEY: ARTIFACT SAMPLE FORM

SURVEY UNIT __ __ SITE* __ __ __ __ PROV* __ __ MONTH __ __ DAY __ __ RECORDER __ __

| | | CERAMICS | | LITHICS | | | | | | | FEATURES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| QUAD | SAMPTYPE | TYPE | NO | TYPE | COND | MATL | CRTX | LENGTH | THICK | PLPREP | TYPE | *FCR | COLL* |
| | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |
| | | | SITE* | | PROV* | | | | MONTH | DAY | | | |
| | | | | | | | | | | | | | |
| | | TYPE | | TYPE | COND | MATL | CRTX | LENGTH | | PLPREP | TYPE | *FCR | COLL* |
| | | | | | | | | | | | | | |
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PAGE __ OF __

# ARTIFACT SAMPLE FORM CODING GUIDE

## CLERICAL DATA

*MONTH/DAY*
*RECORDER:* Recorder's initials.

## PROVENIENCE DATA

*SURVEY UNIT#*
*SITE#*
*PROVENIENCE#*
*QUAD:* NW, NE, SE, SW

## CERAMIC DATA

*TYPE:* Ceramic type code. The codes listed below are a *SUMMARY* of the ceramic type codes. Additional codes for incomplete IDs (i.e., not to the "type" level) are listed on the attached diagrams. Use these codes if you are not (collectively as a crew) sure of the specific type ID and collect the sherd if there is enough to take ID efforts any further (i.e., if the sherd is large enough and/or not sand blasted). If it is TRULY unknown, collect it with the same provisions. Please note rim profiles for all El Paso Brownware types in narrative section of site form.

| | |
|---|---|
| 03 | unspecific El Paso Brown |
| 04* | El Paso Plain Brown (note rim profile) |
| 06* | El Paso Bichrome (note rim profile) |
| 07* | El Paso Polychrome (note rim profile) |
| 11 | smudged, corrugated "Other Brown" |
| 12 | corrugated "Other Brown" |
| 13 | textured "Other Brown" |
| 14 | plain "Other Brown" |
| 15 | Mogollon Red–on–Brown |
| 23 | Three Circle Red–on–White |
| 24 | Mimbres Polychrome |
| 26 | Mimbres Boldface Black–on–White (Style I) |
| 28 | Mimbres Transitional Black–on–White (Style II) |
| 29 | Mimbres Classic Black–on–White (Style III) |
| 30 | Mimbres Black–on–White—"truly" indet. |
| 32 | Socorro Black–on–White |
| 33 | Chupadero Black–on–White |
| 34 | Cibola Whiteware |
| 35 | San Marcial Black–on–White |
| 37 | Gila Polychrome |
| 38 | Magdalena Black–on–White |
| 42 | San Francisco Red |
| 43 | Plain "other" Red |
| 44 | Playas Red |
| 47 | Lincoln Black–on–Red |
| 48 | White Mountain Redwares |
| 50 | Rio Grande Glazewares |
| 61 | Red–on–Terracotta Wares |
| 75 | Tuscon Polychrome |
| 80 | Mexican Polychromes |
| 85 | Corrugated Graywares |
| 86 | Plain Graywares |
| 99* | Unknown (collect) |

*NO:* Number of sherds of TYPE "nn" in sample.

## LITHIC DATA

*TYPE:* Lithic artifact type.

*Debitage*

01 Angular Debris (cannot distinguish ventral/dorsal surface)
02 Flake (can distinguish ventral/dorsal surface)
03 Bifacial Flake (biface thinning; curved,thin,prep. plat.)
04 Sharpening Flake (small, thin, may be pressure)

*Cores*

10 Tested Rock (<2 flakes removed)
11 Irregular Core ("catchall" core category)
12 Bifacial Core/Chopper (>3 cm thick)
13 Blade/Unidirectional Core (single large platform)
14 Tabular Blank (occurs naturally in tabular form)

*Tools*

20 Hammerstone (cobble with battered end/side—not core)
21 Anvil Stone (manuport with battered surface)
22 Retouched Angular Deb (ret scars >2 mm, consist pattn)
23 Retouched Flake (ret scars >2 mm, consist pattn)
24 Projectile Point
25 Biface/Knife (<3 cm thick)
26 Uniface/Scaper (predominantly unidir retouch)
27 Drill/Graver (retouched projection—pronounced)
28 Spokeshave (retouched concavity—pronounced)

*Groundstone*

40 Unknown Ground Stone (indet grdst frag)
41 Mano—unknown (indet mano frag)
42 One–hand Mano
43 Two–hand Mano
44 Metate—unknown (indet mano frag)
45 Slab Metate (rel flat grinding surface)
46 Basin Metate (concave grinding surface)
47 Boulder Mortar
48 Trough Metate
49 Grooved Sandstone, etc.
51 Other (indet—use sparingly)

*COND:* Condition or completeness of artifact.

1 Unknown Frag (all ang deb)
2 Proximal
3 Medial
4 Distal
5 Lateral
6 Complete
7 Used (cores only)
8 Burned (groundstone and cores only)

*MATL:* Generic lithic material type.

| | |
|---|---|
| 01 | Chert—waxy/vitreous; fine-grained |
| 02 | Chert—dull; coarse-grained |
| 03 | Chalcedony |
| 04 | Silc Wood |
| 05 | Quartzite |
| 06 | Obsidian |
| 07 | Basalt |
| 08 | Rhyolite |
| 09 | Sandstone |
| 10 | Granite |
| 11 | Volcanic Porphry |
| 12 | Carbonates (limestones) |
| 13 | Other |
| 14 | Unk. A (quartzite?mudstone?rhyolite?) |

*CORTEX:* Percent cortex class.

| | |
|---|---|
| 0 | 0% ("none") |
| 1 | 1–10% ("smidge") |
| 2 | 11–30% ("some") |
| 3 | 31–80% ("lots") |
| 4 | 81–100% ("like *totally* cortex") |

*LENGTH/THICK:* Length/thickness in mm; round to nearest 10 mm for artifacts >10 mm. For flakes, measure length (perpendicular to platform) for complete specimens only—measure thickness for all flakes. Do not measure angular debris. Use maximum dimensions for all other lithic tools. Use mm scale (on attached BS–85 TRU form) or tape measure.

*PLPREP:* Platform preparation class.

| | |
|---|---|
| 1 | Collapsed |
| 2 | Cortical |
| 3 | Single Facet |
| 4 | Multi–facet |
| 5 | Prepared (retouched, stepped, ground) |

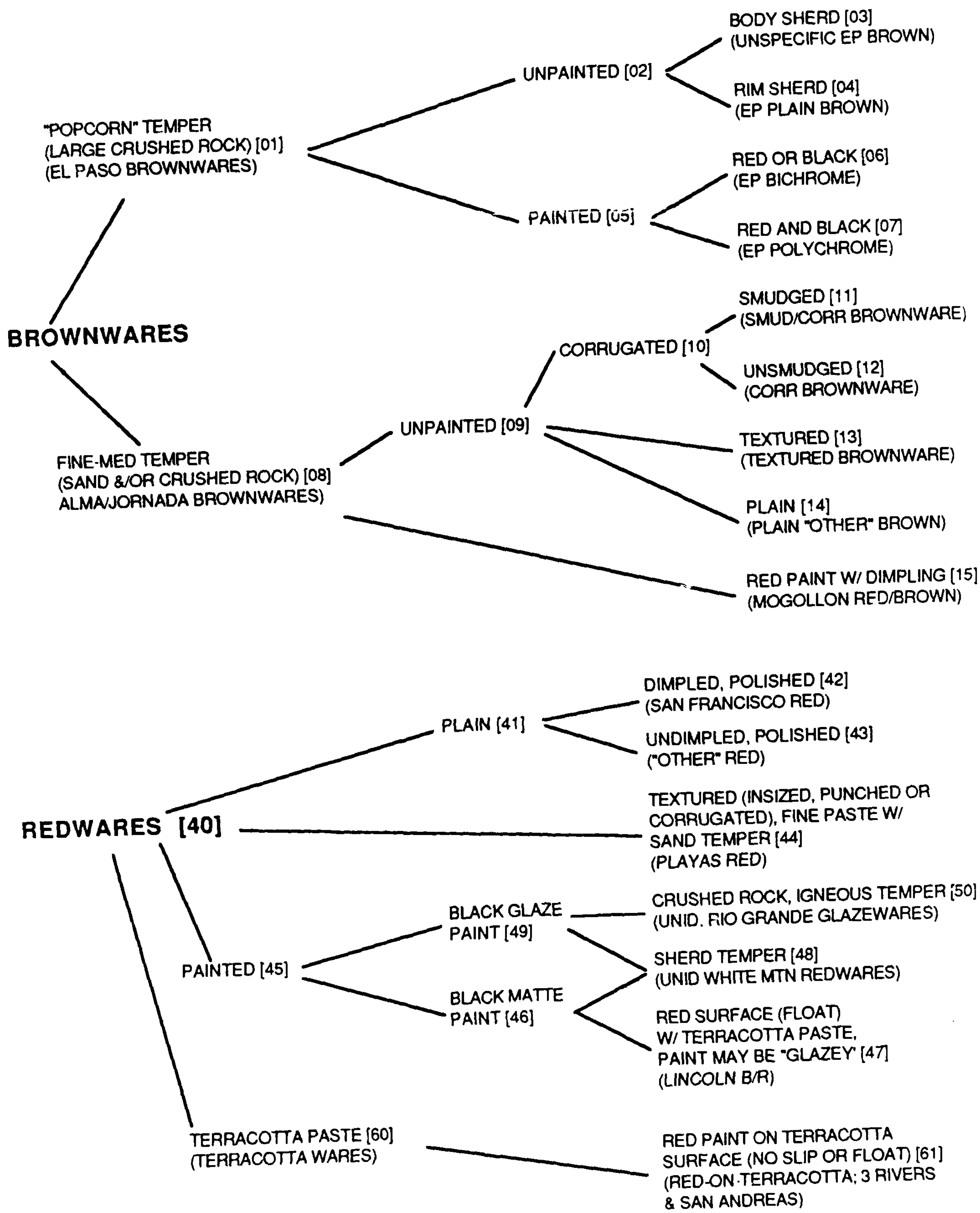
**FEATURE DATA**

*TYPE:* Feature type—to be used for *truly* isolated features (i.e., no associated artifacts) as part of I/O recording.

| | |
|---|---|
| 05 | Concentrated Fire–Cracked Rock/Burned Caliche (discernable config) |
| 06 | Scattered Fire–Cracked Rock/Burned Caliche (no discernable config) |
| 12 | Charcoal Stain |
| 16 | Historic (non–military) |
| 17 | Other |

*#FCR:* Count of fire–cracked rock/burned caliche fragments (>3 cm) in sample or I/O observation.

*COLL#:* Number assigned to each collected artifact—sequential within each Survey Unit. No I/O Collections will be made.


BROWNWARES
"POPCORN" TEMPER (LARGE CRUSHED ROCK) [01] (EL PASO BROWNWARES)
UNPAINTED [02]
BODY SHERD [03] (UNSPECIFIC EP BROWN)
RIM SHERD [04] (EP PLAIN BROWN)
PAINTED [05]
RED OR BLACK [06] (EP BICHROME)
RED AND BLACK [07] (EP POLYCHROME)
FINE-MED TEMPER (SAND &/OR CRUSHED ROCK) [08] ALMA/JORNADA BROWNWARES)
UNPAINTED [09]
CORRUGATED [10]
SMUDGED [11] (SMUD/CORR BROWNWARE)
UNSMUDGED [12] (CORR BROWNWARE)
TEXTURED [13] (TEXTURED BROWNWARE)
PLAIN [14] (PLAIN "OTHER" BROWN)
RED PAINT W/ DIMPLING [15] (MOGOLLON RED/BROWN)
REDWARES [40]
PLAIN [41]
DIMPLED, POLISHED [42] (SAN FRANCISCO RED)
UNDIMPLED, POLISHED [43] ("OTHER" RED)
TEXTURED (INSIZED, PUNCHED OR CORRUGATED), FINE PASTE W/ SAND TEMPER [44] (PLAYAS RED)
PAINTED [45]
BLACK GLAZE PAINT [49]
CRUSHED ROCK, IGNEOUS TEMPER [50] (UNID. RIO GRANDE GLAZEWARES)
BLACK MATTE PAINT [46]
SHERD TEMPER [48] (UNID WHITE MTN REDWARES)
RED SURFACE (FLOAT) W/ TERRACOTTA PASTE, PAINT MAY BE "GLAZEY" [47] (LINCOLN B/R)
TERRACOTTA PASTE [60] (TERRACOTTA WARES)
RED PAINT ON TERRACOTTA SURFACE (NO SLIP OR FLOAT) [61] (RED-ON-TERRACOTTA; 3 RIVERS & SAN ANDREAS)

**WHITEWARES [20]**

- MINERAL PAINT [21]
  - CRUSHED ROCK W/ SAND TEMPER IN GRAY TO BROWN FRIABLE PASTE ALMOST ALWAYS BOWL FORMS [22] (MIMBRES WHITEWARE)
    - RED PAINT [23] (3 CIRCLE RED/WHITE)
    - RED OR ORANGE & BLACK PAINT [24] (MIMBRES POLYCHROME)
    - BLACK PAINT [25]
      - NO BANDS, DESIGNS TO RIM THICK LINES ESP. SCROLLS, SQUIGGLES, PENDANTS [26] (STYLE I -- MIMBRES BOLDFACE)
      - THIN LINES [27]
        - NO BANDS, DESIGN TO RIM, THICKER FRAMING LINES IN HATCHED DESIGNS [28] (STYLE II -- MIMBRES TRANSITIONAL)
        - FREESTANDING BANDS, BANDS SEPARATE RIM AREA, THIN FRAMING LINES IN HATCHED DESIGNS [29] (STYLE III -- MIMBRES CLASSIC)
      - NO LINE JUNCTURES OR DIAGONALS PRESENT [30] ("TRULY" INDET. MIMBRES)
  - FINE IGNEOUS (BLACK) HOMOG. TEMPER IN HARD GRAY PASTE [31]
    - SLIP MATCHES PASTE, NO SCORING [32] (SOCORRO B/W)
    - SLIP WHITER THAN PASTE, SLIP OFTEN CRACKLED/CRAZED, UNSLIPPED SURFACE USU. SCORED, MOSTLY JAR FORMS [33] (CHUPADERO B/W)
  - 
    - SHERD TEMPER, WHITE TO GRAY PASTE [34] (CIBOLA WHITEWARES)
    - SAND TEMPER PROTRUDING THRU YELLOWISH SURFACE, SOME HORNBLENDE-LATITE IN TEMPER, PAINT OFTEN RED-BROWN [35] (SAN MARCIAL B/W)
- CARBON PAINT [36]
  - PARTIAL RED SLIP [37] (GILA POLYCHROME)
  - BLACK ON WHITE ONLY [38] (CF MAGDELENA B/W)

**OTHER TYPES:**

TUSCON POLYCHROME [75]
BROWN-RED PASTE, BLACK & WHITE PAINT, 4-MILE OR KAYENTA POLYCHROME DESIGNS

MEXICAN POLYCHROMES [80]
FINE PASTES SIMILAR TO PLAYAS RED, SAND TEMPER, WHITE OR RED SLIP, RAMOS POLY MOST COMMON (BLACK & RED NARROW LINES ON WHITE)

GRAYWARES (MOSTLY CIBOLA)
CORRUGATED [85] AND PLAIN [86]

UNKNOWN [99]

Table A2.1. GBFEL–TIE archeological site data

| LANO | Site# | Alt | Unit | Zone | TempAffil | Defined? | SiteArea | #Provs | MaxDpth | MFCRDen | MArtDens |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 55263 | 1 | Stallion | 2 | 2 | Archaic | Yes | 275 | 1 | 50 | 0.018 | 0.062 |
| 55264 | 2 | Stallion | 21 | 1 | Lithic Unknown | Yes | 2042 | 1 | 0 | 0.002 | 0.017 |
| 55265 | 3 | Stallion | 3 | 2 | Archaic | Yes | 518 | 1 | 50 | 0.01 | 0.102 |
| 55266 | 4 | Stallion | 21 | 1 | Lithic Unknown | Yes | 1885 | 1 | 0 | 0.003 | 0.007 |
| 55267 | 5 | Stallion | 3 | 2 | Archaic | Yes | 78 | 1 | 50 | 0.064 | 0.103 |
| 55268 | 6 | Stallion | 21 | 1 | Lithic Unknown | Yes | 542 | 1 | 50 | 0.009 | 0.017 |
| 55269 | 7 | Stallion | 3 | 2 | Archaic | No | 743 | 1 | 100 | 0.007 | 0.094 |
| 55270 | 8 | Stallion | 21 | 1 | Multicomp (PFm/Fm) | Yes | 3927 | 1 | 0 | 0.005 | 0.007 |
| 55271 | 9 | Stallion | 1 | 2 | Lithic Unknown | Yes | 377 | 1 | 25 | 0 | 0.095 |
| 55272 | 10 | Stallion | 21 | 1 | Multicomp (PFm/Fm) | Yes | 20452 | 2 | 50 | 0.001 | 0.072 |
| 55273 | 11 | Stallion | 6 | 2 | Multicomp (PFm/Fm) | Yes | 1546 | 1 | 100 | 0.003 | 0.046 |
| 55274 | 12 | Stallion | 23 | 1 | Lithic Unknown | No | 20892 | 1 | 0 | 0.008 | 0.002 |
| 55275 | 13 | Stallion | 6 | 2 | Archaic | No | 48106 | 10 | 100 | 0.034 | 0.084 |
| 55276 | 14 | Stallion | 13 | 1 | Lithic Unknown | Yes | 1728 | 1 | 50 | 0 | 0.019 |
| 55277 | 15 | Stallion | 5 | 2 | Multicomp (PFm/Fm) | Yes | 424 | 1 | 100 | 0.012 | 0.179 |
| 55278 | 16 | Stallion | 13 | 1 | Multicomp (PFm/Fm) | Yes | 1924 | 1 | 100 | 0.003 | 0.044 |
| 55279 | 17 | Stallion | 5 | 2 | Multicomp (PFm/Fm) | Yes | 4555 | 1 | 20 | 0.001 | 0.017 |
| 55280 | 18 | Stallion | 12 | 1 | Multicomp (Fm) | Yes | 15394 | 2 | 70 | 0.002 | 0.005 |
| 55281 | 19 | Stallion | 5 | 2 | Multicomp (PFm/Fm) | Yes | 11545 | 1 | 25 | 0 | 0.008 |
| 55282 | 20 | Stallion | 18 | 1 | Lithic Unknown | Yes | 1257 | 1 | 30 | 0.004 | 0.022 |
| 55283 | 21 | Stallion | 10 | 2 | Archaic | Yes | 6322 | 1 | 50 | 0.001 | 0.026 |
| 55284 | 22 | Stallion | 10 | 2 | Lithic Unknown | Yes | 687 | 1 | 75 | 0.007 | 0.026 |
| 55285 | 23 | Stallion | 30 | 2 | Multicomp (PFm/Fm) | Yes | 9346 | 3 | 100 | 0.047 | 0.031 |
| 55286 | 24 | Stallion | 15 | 1 | Lithic Unknown | Yes | 113 | 1 | 40 | 0.044 | 0.133 |
| 55287 | 25 | Stallion | 30 | 2 | Multicomp (PFm/Fm) | Yes | 6322 | 1 | 10 | 0.001 | 0.043 |
| 55288 | 26 | Stallion | 28 | 1 | Archaic | Yes | 4006 | 1 | 30 | 0.005 | 0.068 |
| 55289 | 27 | Stallion | 29 | 1 | Historic | Yes | 3880 | 1 | 0 | 0 | • |
| 55290 | 30 | Stallion | 25 | 1 | Lithic Unknown | Yes | 605 | 1 | 10 | 0.008 | 0.041 |
| 55291 | 31 | Stallion | 25 | 1 | Lithic Unknown | Yes | 396 | 1 | 10 | 0.051 | 0.025 |
| 55292 | 32 | Stallion | 20 | 1 | Lithic Unknown | Yes | 141 | 1 | 20 | 0 | 0.085 |
| 55295 | 29 | NASA | 53 | 2 | Multicomp (PFm/Fm) | Yes | 323977 | 9 | 150 | 0.111 | • |
| 55296 | 40 | NASA | 52 | 2 | Mesilla Phase | Yes | 418 | 1 | 50 | 0 | 0.847 |
| 55297 | 41 | NASA | 45 | 3 | Multicomp (PFm/Fm) | Yes | 3142 | 1 | 75 | 0.006 | 0.05 |
| 55298 | 43 | NASA | 56 | 1 | Archaic | Yes | 401 | 1 | 30 | 0.012 | 0.065 |
| 55299 | 44 | NASA | 50 | 1 | El Paso Phase | Yes | 1100 | 1 | 50 | 0.018 | 0.013 |
| 55300 | 45 | NASA | 56 | 1 | Archaic | Yes | 11310 | 2 | 50 | 0 | 0.041 |
| 55301 | 46 | NASA | 51 | 2 | El Paso Phase | No | 10996 | 1 | 50 | 0.005 | • |
| 55302 | 47 | NASA | 56 | 1 | Multicomp (PFm/Fm) | No | 7854 | 2 | 50 | 0 | 0.175 |
| 55303 | 48 | NASA | 57 | 1 | Archaic | Yes | 441 | 1 | 50 | 0.045 | 0.15 |
| 55304 | 49 | NASA | 56 | 1 | Multicomp (PFm/Fm) | Yes | 314 | 1 | 75 | 0 | 0.086 |
| 55305 | 50 | NASA | 43 | 3 | Multicomp (PFm/Fm) | Yes | 4006 | 3 | 20 | 0.238 | 0.059 |
| 55306 | 51 | NASA | 43 | 3 | El Paso Phase | Yes | 25 | 1 | 10 | 0.199 | 0.716 |
| 55307 | 52 | NASA | 43 | 3 | Multicomp (Fm) | No | 58905 | 4 | 30 | 0.052 | 0.049 |
| 55308 | 53 | NASA | 40 | 2 | El Paso Phase | Yes | 1963 | 2 | 10 | 0.014 | 0.037 |
| 55309 | 55 | NASA | 40 | 2 | Multicomp (Fm) | No | 118 | 1 | 10 | 0.042 | 0.187 |
| 55310 | 56 | NASA | 40 | 2 | Multicomp (PFm/Fm) | No | 30159 | 4 | 20 | 0.095 | • |
| 55311 | 57 | NASA | 40 | 2 | Multicomp (PFm/Fm) | No | 39270 | 3 | 20 | 0.026 | 0.054 |
| 55312 | 58 | NASA | 46 | 3 | Archaic | No | 31416 | 1 | 10 | 0.038 | 0.039 |
| 55313 | 59 | NASA | 46 | 3 | Mesilla Phase | Yes | 16965 | 2 | 20 | 0.068 | 0.03 |
| 55314 | 60 | NASA | 57 | 1 | Lithic Unknown | Yes | 1206 | 1 | 30 | 0 | 0.036 |
| 55315 | 61 | NASA | 56 | 1 | Archaic | Yes | 127 | 1 | 60 | 0.157 | 0.126 |
| 55316 | 62 | NASA | 34 | 3 | Lithic Unknown | Yes | 1374 | 1 | 50 | 0.004 | 0.02 |
| 55317 | 63 | NASA | 48 | 2 | Multicomp (PFm/Fm) | Yes | 6637 | 1 | 75 | 0.024 | 0.087 |
| 55318 | 64 | NASA | 34 | 3 | Archaic | Yes | 707 | 2 | 30 | 0.81 | 0.363 |
| 55319 | 65 | NASA | 48 | 2 | Multicomp (Fm) | Yes | 942 | 1 | 60 | 0.021 | 0.117 |

(continued)

Table A2.1. (continued)

| LANO | Site# | Alt | Unit | Zone | TempAffil | Defined? | SiteArea | #Provs | MaxDpth | MFCRDen | MArtDens |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 55320 | 66 | NASA | 35 | 2 | Multicomp (PFm/Fm) | Yes | 5655 | 1 | 50 | 0.011 | 0.048 |
| 55321 | 67 | NASA | 48 | 2 | El Paso Phase | No | 7069 | 1 | 60 | 0.023 | • |
| 55322 | 68 | NASA | 35 | 2 | Archaic | Yes | 2501 | 1 | 50 | 0 | 0.045 |
| 55323 | 69 | NASA | 48 | 2 | Multicomp (PFm/Fm) | No | 78540 | 3 | 60 | 0.7 | • |
| 55324 | 70 | NASA | 37 | 2 | Multicomp (Fm) | Yes | 54978 | 1 | 100 | 0.003 | • |
| 55325 | 71 | NASA | 49 | 1 | El Paso Phase | No | 7147 | 1 | 100 | 0.082 | 0.056 |
| 55326 | 72 | NASA | 33 | 3 | Archaic | Yes | 2985 | 1 | 50 | 0 | 0.048 |
| 55327 | 73 | NASA | 49 | 1 | Multicomp (PFm/Fm) | Yes | 8482 | 2 | 150 | 0.058 | 0.035 |
| 55328 | 75 | NASA | 49 | 1 | El Paso Phase | No | 314160 | 4 | 100 | 0.025 | 0.053 |
| 55329 | 77 | NASA | 49 | 1 | Multicomp (Fm) | No | 192423 | 4 | 60 | 1.05 | • |
| 55330 | 79 | NASA | 41 | 2 | Multicomp (Fm) | No | 129591 | 3 | 100 | 0.038 | • |
| 55331 | 81 | NASA | 42 | 2 | Multicomp (Fm) | Yes | 1963 | 2 | 100 | 0.07 | 0.155 |
| 55332 | 83 | NASA | 42 | 2 | Multicomp (Fm) | No | 11781 | 2 | 80 | 0.286 | • |
| 55333 | 85 | NASA | 41 | 2 | El Paso Phase | Yes | 2309 | 1 | 50 | 0.002 | 0.024 |
| 55334 | 87 | NASA | 42 | 2 | Mesilla Phase | Yes | 236 | 1 | 60 | 0.085 | 0.055 |
| 55335 | 201 | NASA | 46 | 3 | Multicomp (Fm) | Yes | 3299 | 1 | 20 | 0.049 | • |
| 55336 | 202 | NASA | 46 | 3 | Lithic Unknown | Yes | 118 | 1 | 20 | 0.042 | 0.136 |
| 55648 | 301 | NASA | 58 | 1 | Multicomp (PFm/Fm) | No | 277089 | 6 | 60 | 0.037 | • |
| 55649 | 302 | NASA | 60 | 1 | Multicomp (PFm/Fm) | No | 486461 | 2 | 50 | 0.056 | • |
| 55650 | 303 | NASA | 61 | 1 | Multicomp (Fm) | No | 157080 | 4 | 100 | 0.067 | • |
| 55651 | 305 | NASA | 61 | 1 | Multicomp (PFm/Fm) | No | 27646 | 1 | 20 | 0.012 | • |
| 55652 | 307 | NASA | 62 | 1 | Mesilla Phase | Yes | 2513 | 1 | 50 | 0.024 | • |
| 55653 | 308 | NASA | 62 | 1 | Multicomp (Fm) | Yes | 1414 | 1 | 40 | 0.085 | • |
| 55654 | 309 | NASA | 62 | 1 | Multicomp (Fm) | No | 19635 | 1 | 60 | 0.008 | • |
| 55655 | 310 | NASA | 62 | 1 | Multicomp (Fm) | Yes | 2749 | 1 | 30 | 0.085 | • |
| 55656 | 311 | NASA | 62 | 1 | Multicomp (Fm) | Yes | 6283 | 2 | 40 | 0.084 | • |

Key

| Variable | Definition |
|---|---|
| LANO | Laboratory of Anthropology site number |
| Site# | GBFEL-TIE field site number |
| Alt | Alternative |
| Unit | Sample survey unit (see Figures 1.1 and 1.2) |
| Zone | Environmental Zone (see Figures 1.1 and 1.2) |
| TempAffil | Temporal affiliation |
| Defined? | Site completely defined? |
| SiteArea | Site area in square meters |
| #Provs | Number of recorded and sampled proveniences |
| MaxDpth | Maximum site depth estimate |
| MFCRDen | Mean fire-cracked rock density expressed as number of fragments per square meter |
| MArtDens | Mean artifact density expressed as number of fragments per square meter |

Table A2.2. GBFEL–TIE archeological site data

| LANO | ArtTot | #Hrth | StrFeat | #Ltypes | #CTypes | #MTypes | Core% | Pnd% | InfT% | FT% | GSt% | #Tools | TotDeb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55263 | 17 | 0 | 0 | 5 | • | 7 | 0 | 0 | 0 | 0.33 | 0.67 | 3 | 14 |
| 55264 | 34 | 0 | 0 | 7 | • | 7 | 0.2 | 0 | 0 | 0 | 0.8 | 5 | 29 |
| 55265 | 53 | 0 | 0 | 7 | • | 8 | 0 | 0 | 0 | 0.67 | 0.33 | 3 | 45 |
| 55266 | 14 | 0 | 0 | 3 | • | 7 | 0 | 0 | 0 | 0 | 1 | 2 | 12 |
| 55267 | 8 | 0 | 0 | 4 | • | 4 | 0 | 0 | 0.33 | 0.67 | 0 | 3 | 5 |
| 55268 | 9 | 0 | 0 | 3 | • | 5 | • | • | • | • | • | 0 | 8 |
| 55269 | 70 | 0 | 0 | 5 | • | 4 | 0 | 0 | 0 | 0 | 1 | 2 | 67 |
| 55270 | 26 | 0 | 0 | 6 | 1 | 8 | 0.2 | 0 | 0 | 0.6 | 0.2 | 5 | 20 |
| 55271 | 36 | 0 | 0 | 5 | • | 6 | 1 | 0 | 0 | 0 | 0 | 2 | 34 |
| 55272 | 1285 | 0 | 0 | 16 | 1 | 12 | 0.04 | 0.04 | 0.12 | 0.19 | 0.62 | 52 | 41 |
| 55273 | 71 | 0 | 0 | 5 | 1 | 8 | 0 | 0 | 0 | 0.5 | 0.5 | 2 | 69 |
| 55274 | 51 | 0 | 0 | 10 | • | 8 | 0.05 | 0 | 0.05 | 0.1 | 0.8 | 20 | 31 |
| 55275 | 325 | 0 | 0 | 18 | • | 14 | 0.08 | 0.08 | 0.21 | 0.1 | 0.54 | 39 | 209 |
| 55276 | 33 | 0 | 0 | 8 | • | 7 | 0.3 | 0 | 0.1 | 0.1 | 0.5 | 10 | 23 |
| 55277 | 76 | 0 | 0 | 8 | 3 | 8 | 0 | 0 | 0.5 | 0.17 | 0.33 | 6 | 61 |
| 55278 | 84 | 0 | 0 | 13 | 1 | 8 | 0 | 0 | 0.12 | 0.47 | 0.41 | 17 | 28 |
| 55279 | 79 | 0 | 0 | 10 | 2 | 8 | 0.17 | 0 | 0.17 | 0.33 | 0.33 | 6 | 71 |
| 55280 | 25 | 0 | 0 | 8 | 2 | 7 | 0 | 0 | 0.29 | 0.29 | 0.43 | 7 | 16 |
| 55281 | 98 | 0 | 0 | 11 | 1 | 9 | 0.15 | 0 | 0.31 | 0.38 | 0.15 | 13 | 85 |
| 55282 | 28 | 0 | 0 | 7 | • | 6 | 0.05 | 0 | 0 | 0 | 0.95 | 22 | 6 |
| 55283 | 165 | 0 | 0 | 8 | • | 9 | 0.2 | 0.1 | 0.4 | 0.3 | 0 | 10 | 155 |
| 55284 | 18 | 0 | 0 | 6 | • | 5 | 0 | 0 | 0.1 | 0.2 | 0.7 | 10 | 8 |
| 55285 | 131 | 1 | 0 | 12 | • | 9 | 0.1 | 0.05 | 0.6 | 0.15 | 0.1 | 20 | 79 |
| 55286 | 15 | 0 | 0 | 7 | • | 7 | 0.08 | 0 | 0 | 0.08 | 0.85 | 13 | 2 |
| 55287 | 272 | 0 | 0 | 6 | 1 | 7 | 0 | 0 | 0.67 | 0.33 | 0 | 9 | 111 |
| 55288 | 274 | 0 | 0 | 11 | • | 11 | 0.21 | 0.05 | 0 | 0.21 | 0.53 | 19 | 56 |
| 55289 | • | 0 | 0 | • | • | • | • | • | • | • | • | • | • |
| 55290 | 25 | 0 | 0 | 4 | • | 5 | 0.5 | 0 | 0.5 | 0 | 0 | 2 | 23 |
| 55291 | 10 | 0 | 0 | 7 | • | 4 | 0.17 | 0.17 | 0.33 | 0 | 0.33 | 6 | 4 |
| 55292 | 12 | 0 | 0 | 3 | • | 3 | 1 | 0 | 0 | 0 | 0 | 2 | 10 |
| 55295 | • | 1 | 0 | 17 | 24 | 10 | 0.19 | 0 | 0.14 | 0.25 | 0.42 | 36 | 160 |
| 55296 | 354 | 0 | 3 | 10 | 13 | 8 | 0.08 | 0 | 0 | 0.33 | 0.58 | 12 | 6 |
| 55297 | 156 | 0 | 0 | 7 | 9 | 6 | 0.33 | 0 | 0.33 | 0.33 | 0 | 3 | 62 |
| 55298 | 26 | 0 | 0 | 5 | • | 5 | 0 | 0 | 0 | 0.5 | 0.5 | 2 | 24 |
| 55299 | 14 | 0 | 0 | 5 | 5 | 5 | 0 | 0 | 0 | 0.25 | 0.75 | 4 | 5 |
| 55300 | 98 | 0 | 0 | 11 | • | 5 | 0.2 | 0 | 0.5 | 0.2 | 0.1 | 10 | 90 |
| 55301 | • | 0 | 0 | 12 | 8 | 7 | 0.24 | 0 | 0.05 | 0.48 | 0.24 | 21 | 29 |
| 55302 | 118 | 0 | 0 | 8 | 1 | 4 | 0.13 | 0 | 0.5 | 0 | 0.38 | 8 | 109 |
| 55303 | 66 | 0 | 0 | 9 | • | 5 | 0 | 0 | 0.12 | 0 | 0.88 | 17 | 21 |
| 55304 | 27 | 0 | 0 | 7 | 1 | 6 | 0 | 0 | 0.09 | 0.18 | 0.73 | 11 | 16 |
| 55305 | 118 | 0 | 3 | 12 | 3 | 7 | 0.25 | 0 | 0.05 | 0.25 | 0.45 | 20 | 46 |
| 55306 | 18 | 0 | 0 | 1 | 1 | 3 | • | • | • | • | • | 0 | 8 |
| 55307 | 24 | 4 | 0 | 14 | 14 | 7 | 0.35 | 0 | 0.24 | 0.29 | 0.12 | 17 | 19 |
| 55308 | 31 | 0 | 0 | 5 | 1 | 5 | 0.33 | 0 | 0 | 0 | 0.67 | 3 | 27 |
| 55309 | 22 | 0 | 0 | 8 | 1 | 4 | 0.44 | 0 | 0 | 0 | 0.56 | 9 | 12 |
| 55310 | • | 1 | 0 | 18 | 7 | 8 | 0.37 | 0.02 | 0.06 | 0.22 | 0.33 | 49 | 61 |
| 55311 | 102 | 0 | 0 | 12 | 16 | 6 | 0.46 | 0 | 0.08 | 0.15 | 0.31 | 13 | 83 |
| 55312 | 62 | 0 | 0 | 11 | • | 8 | 0.05 | 0.1 | 0.1 | 0.24 | 0.52 | 21 | 21 |
| 55313 | 78 | 2 | 0 | 12 | 1 | 6 | 0.53 | 0 | 0.07 | 0.2 | 0.2 | 15 | 52 |
| 55314 | 44 | 0 | 0 | 10 | • | 4 | 0 | 0 | 0.25 | 0.13 | 0.63 | 8 | 32 |
| 55315 | 16 | 0 | 0 | 6 | • | 4 | 0.33 | 0 | 0 | 0 | 0.67 | 3 | 13 |
| 55316 | 28 | 0 | 0 | 5 | • | 3 | 0.33 | 0 | 0 | 0 | 0.67 | 3 | 22 |
| 55317 | 580 | 1 | 0 | 5 | 2 | 5 | 0 | 0 | 0 | 0.5 | 0.5 | 2 | 54 |
| 55318 | 242 | 2 | 0 | 8 | • | 6 | 0.25 | 0 | 0.25 | 0 | 0.5 | 4 | 70 |
| 55319 | 110 | 0 | 0 | 6 | 5 | 7 | 0.2 | 0 | 0.4 | 0 | 0.4 | 5 | 27 |

(continued)

Table A2.2. (continued)

| LANO | ArtTot | #Hrth | StrFeat | #Ltypes | #CTypes | #MTypes | Core% | Pnd% | InfT% | FT% | GSt% | #Tools | TotDeb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55320 | 273 | 4 | 0 | 11 | 3 | 7 | 0.08 | 0 | 0.23 | 0.23 | 0.46 | 13 | 95 |
| 55321 | • | 0 | 0 | 6 | 7 | 6 | 0.5 | 0 | 0 | 0 | 0.5 | 6 | 41 |
| 55322 | 112 | 0 | 0 | 9 | • | 7 | 0.17 | 0 | 0.33 | 0.33 | 0.17 | 12 | 48 |
| 55323 | • | 1 | 0 | 14 | 7 | 8 | 0 | 0.05 | 0.33 | 0.38 | 0.24 | 21 | 223 |
| 55324 | • | 0 | 2 | 12 | 22 | 10 | 0.02 | 0 | 0.05 | 0.1 | 0.83 | 60 | 3 |
| 55325 | 108 | 0 | 0 | 11 | 4 | 6 | 0.21 | 0.05 | 0.26 | 0.16 | 0.32 | 19 | 81 |
| 55326 | 144 | 0 | 0 | 14 | 2 | 8 | 0.09 | 0.05 | 0.36 | 0.36 | 0.14 | 22 | 115 |
| 55327 | 185 | 0 | 0 | 10 | 5 | 6 | 0.2 | 0 | 0.4 | 0.3 | 0.1 | 10 | 35 |
| 55328 | 61 | 0 | 0 | 9 | 5 | 9 | 0.25 | 0 | 0.06 | 0.44 | 0.25 | 16 | 55 |
| 55329 | • | 0 | 0 | 12 | 11 | 12 | 0.33 | 0 | 0.11 | 0.19 | 0.36 | 36 | 80 |
| 55330 | • | 0 | 1 | 16 | 19 | 9 | 0.42 | 0 | 0.15 | 0.08 | 0.35 | 26 | 107 |
| 55331 | 52 | 1 | 0 | 4 | 8 | 3 | 0.75 | 0.25 | 0 | 0 | 0 | 4 | 24 |
| 55332 | • | 0 | 0 | 11 | 10 | 7 | 0.08 | 0 | 0.15 | 0.38 | 0.38 | 13 | 68 |
| 55333 | 56 | 0 | 0 | 2 | 5 | 3 | • | • | • | • | • | 0 | 10 |
| 55334 | 13 | 0 | 0 | 3 | 2 | 4 | 0.5 | 0 | 0 | 0 | 0.5 | 2 | 4 |
| 55335 | • | 5 | 0 | 12 | 2 | 6 | 0.15 | 0.08 | 0.15 | 0.46 | 0.15 | 13 | 36 |
| 55336 | 16 | 0 | 0 | 6 | • | 3 | 0.17 | 0 | 0 | 0 | 0.83 | 6 | 10 |
| 55648 | • | 8 | 0 | 12 | 18 | 6 | 0.2 | 0.04 | 0.12 | 0.08 | 0.56 | 25 | 0 |
| 55649 | • | 2 | 0 | 7 | 10 | 3 | 0.11 | 0 | 0.44 | 0.33 | 0.11 | 9 | 0 |
| 55650 | • | 6 | 0 | 12 | 11 | 5 | 0.16 | 0.04 | 0.2 | 0.12 | 0.48 | 25 | 0 |
| 55651 | • | 2 | 0 | 6 | 2 | 3 | 0.25 | 0 | 0.13 | 0 | 0.63 | 8 | 0 |
| 55652 | • | 1 | 0 | 5 | 3 | 4 | 0.5 | 0 | 0.25 | 0 | 0.25 | 4 | 11 |
| 55653 | • | 2 | 0 | 5 | 2 | 3 | 0.22 | 0 | 0.56 | 0.11 | 0.11 | 9 | 0 |
| 55654 | • | 1 | 3 | 1 | 12 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 55655 | • | 1 | 0 | 5 | 4 | 4 | 0 | 0 | 0.25 | 0.25 | 0.5 | 4 | 1 |
| 55656 | • | 2 | 0 | 8 | 6 | 5 | 0.33 | 0.2 | 0.07 | 0.07 | 0.33 | 15 | 0 |

Key

| Variable | Definition |
|---|---|
| LANO | Laboratory of Anthropology site number |
| ArtTot | Total number of artifacts (#Tools+TotDeb) |
| #Hrth | Total number of recorded hearth features |
| StrFeat | Total number of recorded architectural features |
| #Ltypes | Number of different lithic artifact types |
| #CTypes | Number of different ceramic types |
| #MTypes | Number of different lithic material types |
| Core% | Proportion of assemblage consisting of cores |
| Pnd% | Proportion of assemblage consisting of pounding implements (see coding guide) |
| InfT% | Proportion of assemblage consisting of informal tools (retouched debitage) |
| FT% | Proportion of assemblage consisting of formal tools (see coding guide) |
| GSt% | Proportion of assemblage consisting of grinding implements (see coding guide) |
| #Tools | Total number of lithic tools |
| TotDeb | Total debitage |

Appendix 3

# MONITORING IN THE GBFEL–TIE STALLION, NASA, AND OROGRANDE ALTERNATIVES

Peter T. Noyes

*This report was prepared for the U.S. Army Engineer District, Ft. Worth, Contract No. DACW63–86–D–0010, Delivery Order No. 5.*

## Introduction

This report describes the activities and results of an archeological clearance and monitoring project conducted for the U.S. Army Engineer District, Ft. Worth, on White Sands Missile Range in south–central New Mexico. The project was conducted under contract DACW63–86–D–0010, Delivery Order No. 5, by personnel from Prewitt and Associates, Inc., of Austin, Texas, and the Office of Contract Archeology (OCA) of the University of New Mexico in Albuquerque. The purpose of the project was to conduct cultural resource clearance surveys for the access routes and drill pads required by drilling crews undertaking preliminary geotechnical studies in the three alternative locations (Stallion, NASA, and Orogrande) for the GBFEL–TIE project.

Drilling on the three project areas was conducted by five crews assembled from U.S. Army Corps of Engineer offices in Mobile and Memphis and from the Waterways Experimental Station in Vicksburg. Equipment used on the project included five drilling rigs, five water and supply trucks, various two– and four–wheel drive vehicles, and both front–end loaders and road graders loaned to the project by White Sands Missile Range. James Christi of the Fort Worth office of the Corps of Engineers coordinated the project. Andrew Parker from the Mobile Corps office served as field foreman. Mr. Parker was assisted by Charles Fuller and Memphis crew chief George Bualison. Archeological fieldwork was conducted by the author with the assistance of Martha R. Binford, Glenna Dean, Philip J. Arnold III, and James G. Snyder at various times throughout the project.

The primary goal of the clearance and monitoring project was to enable the drilling crews to gather preliminary soils information for geotechnical feasibility studies without substantially impacting cultural resources. The project therefore focused on establishing routes to proposed drilling locations that avoided archeological sites and on locating 1 acre drill pads that were free of surface cultural remains.

The proposed drilling locations were previously surveyed, staked, and flagged by the Basil Smith Engineering Company of El Paso, Texas. These drilling locations were then located by the archeological team, using various maps and aerial photographs. In general, locations of flagged drill sites were discovered by measuring appropriate distances along existing roads and then walking a compass bearing toward the drilling location. Once the previously staked and flagged location was found, a corridor between 6 m and 12 m wide was surveyed and flagged back to the nearest established road.

The project focused primarily on avoidance of archeological remains in each of the three alternatives rather than on documentation of the archeological sites encountered. It was recognized that a previous survey of the Orogrande area and the sample survey of the Stallion and NASA Alternatives, conducted concurrently with the monitoring project, would provide much more useful data concerning the density and variability of archeological remains at each of the alternatives than isolated site descriptions generated by the less systematic clearance survey. Sites encountered while searching for the flagged drilling locations were avoided by this access survey. When sites were encountered during this access survey, the location of the site was recorded, and the access route was altered to avoid the site.

In each of the three alternatives, established roads were not surveyed as part of the monitoring project. Although sites do exist in and along these roads, damage to such sites has already taken place and, since these roads provided essential access to most of the areas, the additional impacts brought about by using and regrading the roads (where necessary) were far outweighed by the additional environmental and archeological impacts that would occur if new roads were surveyed and graded in.

An exception to the above outlined strategy occurred in the NASA Alternative, where overall site density prevented the drilling crews from leaving the established roads. Drilling at the NASA Alternative was limited to nine locations (instead of the planned 16) along three existing roads that cross the area. One of these routes is a

newly established pipeline and road placed by the Jornada Experimental Station between New Well and the western border of the NASA study area. An archeological survey was conducted along this road, since it was apparent that no archeological clearance was conducted prior to placement of the pipeline and bulldozing of the road. Five archeological sites and 21 isolated occurrences were encountered, mapped, and described by the survey; drilling then proceeded outside the site areas at three locations along the pipeline road.

## The Stallion Alternative

The Stallion Alternative location for the GBFEL–TIE Project begins immediately south of the Stallion Range Center of White Sands Missile Range. The study area is a 6.5 mi (11 km) long by 3.5 mi (6 km) wide parcel oriented north and south. The northern boundary of the area is approximately 25 mi (46 km) east of Socorro, New Mexico, and about 5 mi (8 km) south of the Stallion turnoff on U.S. Highway 380.

The sample survey, conducted concurrently with this drilling project, revealed significant archeological remains covering much of the Stallion Alternative area. In general, most of the archeological remains can be characterized as relatively large multicomponent artifact scatters. While the sites tend to cover relatively large areas, there are often fairly large "empty" areas between the sites, which are often broad shallow playas. Many of the sites are located in the low dune fields along the playa edges.

Work in the Stallion area began on June 10, 1986. The preliminary drilling program for the Stallion area specified drill holes at 16 locations (Figure A3.1). One of the proposed holes had to be moved due to an especially large site, LA 55275, which was roughly centered on the drilling location at UTM coordinates Zone 13, 347500 E, 3739500 N. An additional drill hole near the eastern boundary of the study area was offset due to especially loose sand in the high dunes in this area.

The majority of the drilling locations had been staked and flagged prior to fieldwork in the area. The drilling locations were located by archeological crews using 1:10,000 scale, computer–generated maps. The relatively high number of roads already existing in the Stallion area, along with the relatively level nature of the general landform, greatly facilitated both finding and accessing the drilling locations. Site areas observed while trying to find the drilling locations were avoided on the access survey back to the road. Sites located along the access route were marked for avoidance by stretching flagging tape between bushes, creating a very visible barrier for both the grading and drilling equipment. The location of these sites was recorded on field maps, and all but two of them were subsequently recorded during the sample survey.

The disturbance associated with the grading and drilling activities was not dramatic. In general, a single pass with the grading equipment was all that was required to provide access for the drilling crews. Additionally, the existing roads provided much better access to most of the area, so that only relatively shorter access roads had to be graded in. Some disturbance did occur at the drilling locations, where 1 m deep sumps were excavated to hold the water and mud necessary for drilling. The entire surface of each drilling location was leveled and the sumps were backfilled after the holes were completed. In all, 6.2 mi (1.0 km) of new roads were graded in the Stallion area.

## The NASA Alternative

The NASA Alternative location for the GBFEL–TIE Project falls some 30 mi (48 km) northeast of the city of Socorro, New Mexico, along the eastern footslope of the San Andres Mountains. The location is just north of NASA's Lyndon B. Johnson Space Center White Sands Test Facility and immediately west of the San Andres National Wildlife Refuge. The NASA Alternative is entirely within a joint–use area shared by White Sands Missile Range and the Jornada Experimental Range. The Jornada Experimental Station is run by the Agricultural Research Services branch of the United States Department of Agriculture. The NASA Alternative location lies along the western edge of the Jornada Experimental Station near the northern boundary of the station.

The NASA Alternative lies within a biotic community marked by a zone of mesquite–dominated shrubland, which is clearly visible on the USGS 7.5′ Series Quads: Goldenburg Draw, Fleck Draw, San Andres Peak, Gardener Peak, Selden Canyon N.E., and Gilmore Draw, as well as the 1:100,000 scale topographic map of White Sands, New Mexico. This area contains several known archeological sites. Many of these sites were documented during the 1930s and 1940s and have received relatively little attention apart from the destructive activities of pothunters and vandals. The majority of the recorded sites within the mesquite band area contain ceramic types and artifact densities indicative of El Paso phase villages. The number and size of such village sites indicate that this area may well be the center of Jornada Mogollon occupation during the El Paso phase.

An initial reconnaissance of the NASA Alternative revealed that access to the 16 proposed drill locations would not be possible without impacting archeological sites. Several sites had already been impacted by existing roads that ran through the southern half of the study area. As part of the initial reconnaissance, a preliminary survey was conducted along the existing roads in the southern portion of the study area. This survey was conducted by driving along the existing roads and stopping every 0.3 mi (0.5 km) and checking a 250 $m^2$ area (10 x 25 m) for cultural material. Out of 27 stops along the roads between

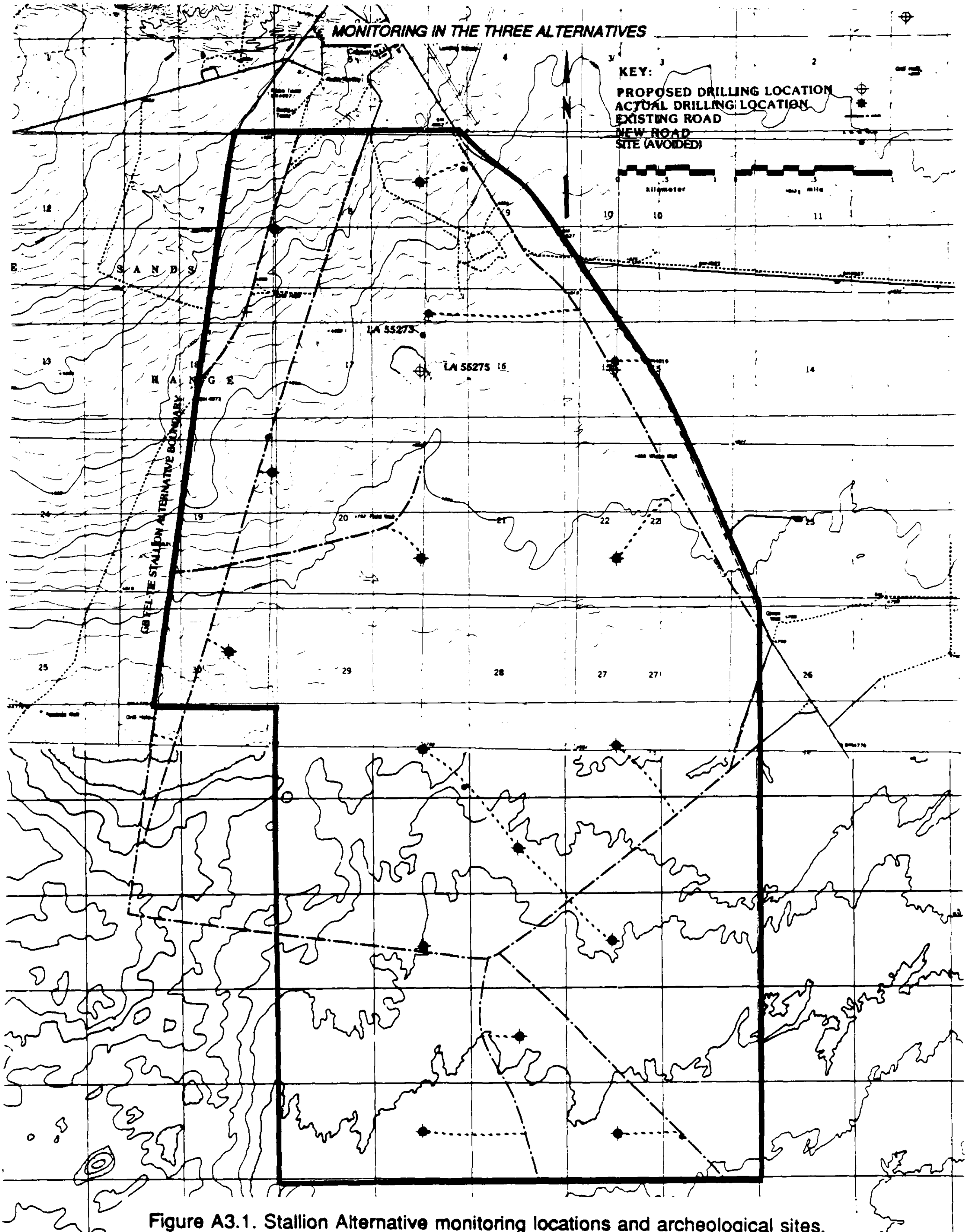



Figure A3.1. Stallion Alternative monitoring locations and archeological sites.

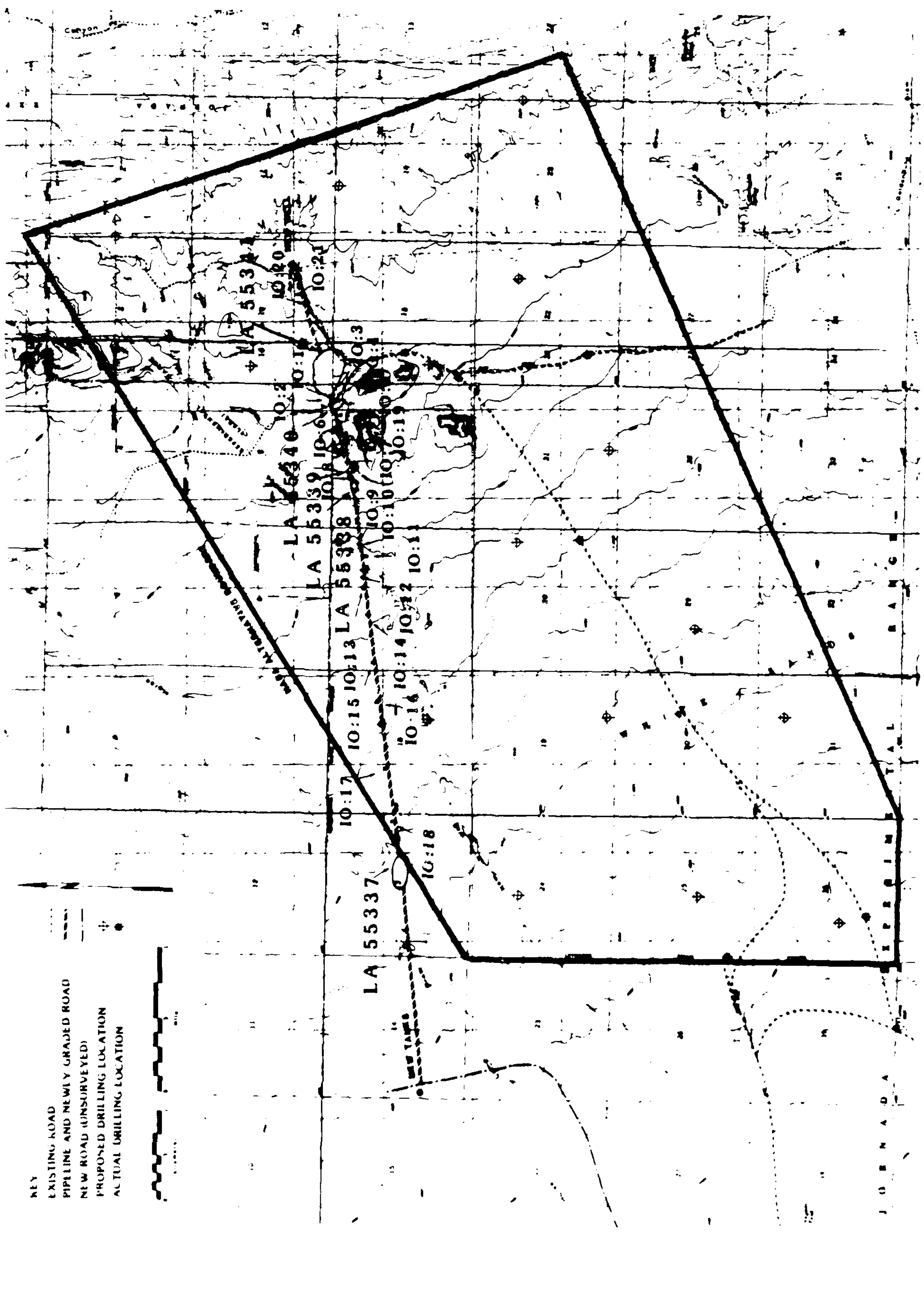



Figure A3.2. NASA Alternative monitoring locations and archeological sites.

Turney Well, New Well, and the southern edge of the survey area (Figure A3.2), 16 stops had cultural material within the 250 $m^2$ area. At four of the stops, cultural material was visible from the road, but was not present within the 250 $m^2$ area. At the remaining seven stops, no cultural material was visible.

While this spot-check survey was not oriented toward site definition or documentation, it was apparent that many sites were present along the existing roads in the southern portion of the NASA Alternative. The results of the Class II survey (conducted concurrently with the drilling program) also indicated a high density of extensive sites throughout the study area. This information was relayed to Peter Eidenbach (CE archeologist at White Sands Missile Range). After consultation with the State Historic Preservation Officer, it was decided to limit drilling activities to existing roads and trails within the NASA Alternative. Regrading of existing roads, where necessary, was permitted in order to allow access to new drilling locations. This regrading was limited, however, to the already disturbed portions of the existing roads; "pushes" of sand and vegetation off the existing roads were not permitted.

Nine new drilling locations were placed on 7.5′ USGS Quads by James Christi of the CE Ft. Worth office. The locations were then found by measuring off appropriate odometer readings. The drilling locations were flagged by the author and Charles Fuller of the CE Mobile office. In the NASA area the drilling areas were flagged as approximate 50 m diameter circles, or "safe areas," where drilling could proceed. This was necessary since sites were so common. It was often necessary to search for several hundred meters along the existing roads in order to find a site-free area large enough to drill. This was especially true on the eastern portion of the NASA Alternative. Care was taken to locate the drill pads in areas sufficiently deflated to indicate that there actually was no cultural material near the surface in the area which would be impacted by drilling activities.

In addition to the pre-existing roads that ran through the southern portion of the NASA study area, a new pipeline and road had been recently constructed in the northern portion of the alternative. The pipeline runs from New Well, near the northeastern corner of the area, to a new set of stock and holding tanks located approximately 2 mi (3.2 km) west of the western boundary of the study area. Construction on the pipeline involved burying 1.5 and 2 inch PVC pipe and bulldozing a four wheel drive access road. The road is generally between 20 and 30 ft (6–10 m) wide, but in many areas entire coppice dunes have been pushed up to 30 ft (10 m) away from the road. The rough, sandy pipeline road now provides the best access to the northern part of the NASA study area. When the road was spot-checked prior to drilling activities, it seemed apparent that no archeological clearance survey had been conducted prior to placement of the pipeline and bulldozing of the road.

A standard archeological survey was conducted along the newly constructed pipeline road. The road was walked from east to west and all artifacts were marked with pinflags as they were encountered. Single artifacts or groups of artifacts with a density of fewer than five items per 100 $m^2$ were recorded as isolated occurrences. Artifact scatters with a density of more than five artifacts per 100 $m^2$ were recorded as sites.

Five sites and 21 isolated occurrences were observed to have been impacted by construction along the pipeline. Brief site descriptions and a list of the isolated occurrences are provided below (Table A3.1). Of the five sites, two are aceramic (probably Archaic) lithic scatters which are visible in the blowouts between the dunes and in the disturbed sand of the impacted area. Two other sites are lithic scatters with very few associated brownware ceramics (El Paso Polychrome and Smudged-corrugated). One site is an extensive El Paso phase village with more than 13 different ceramic types and an extensive midden indicating probable adobe architectural features.

Apparently, the pipeline was constructed by the Jornada Range Management in order to provide water for cattle in pasture lands just outside the joint-use area. Although it is not known what agency coordinated the pipeline construction, two pieces of White Sands Missile Range equipment were parked along the pipeline during the GBFEL-TIE drilling program: a CAT motor grader inscribed with *WSMR E H 6–0915* and *US Army 8C 9708*, and a CAT D8 bulldozer inscribed *TEC WSMR PE 102* and *8 B029*.

On July 4, 1986, while the author was out finishing site descriptions and maps on the pipeline survey, he returned to LA 55341 (an El Paso phase site) and noticed a civilian pickup truck and a family walking over the site. The owner of the pickup said he had heard about the site from friends who had worked on the construction of the pipeline. He insisted that the entire Jornada Range area was "open" and frankly admitted that he was out on the site "hunting points." He was informed by the author that taking artifacts off federally owned archeological sites was illegal and that he was trespassing on federal land.

The nine drilling locations on the NASA Alternative were all situated on or directly adjacent to existing roads in areas that avoided impacts to visible surface archeological sites.

Recent events, including the incident described above as well as the recent arrest and trespassing conviction of two other point hunters on White Sands Missile Range property, indicate that artifact collecting on archeological sites is an ongoing problem on the Jornada Range and adjacent areas. The collector encountered on LA 55341 said he believed that the entire Jornada Range, including the joint-use area, was "open" for collecting. His belief seems to indicate that the Jornada joint-use area may effectively *be* open, in that no monitoring of casual collec

Table A3.1. Isolated occurrences (IO) observed during the pipeline survey

| IO No. | UTM East | UTM North | Description |
|---|---|---|---|
| 1 | 347123 E | 3624582 N | A single, small undifferentiated brown (UB) sherd |
| 2 | 347100 E | 3624585 N | An irregular core of glossy chert measuring 48 x 48 mm. |
| 3 | 347175 E | 3624520 N | A dull chert flake, complete, single facet platform, no cortex, 27 x 4 mm. |
| 4 | 347110 E | 3624510 N | A complete red jasper flake, single facet platform, no cortex, 21 x 3 mm. |
| 5 | 346925 E | 3624150 N | A proximal carbonate flake fragment, single facet platform, no cortex, 7 mm thick. |
| 6 | 346510 E | 3624385 N | A complete basalt flake, cortical platform, no cortex, 4 mm thick. |
| 7 | 346470 E | 3624400 N | A glossy chert proximal flake fragment,single facet platform, 8 mm thick. |
| 8 | 346225 E | 3624245 N | A complete carbonate flake, cortical platform, 50% dorsal cortex, 42 x 10 mm. |
| 9 | 345500 E | 3624260 N | A single UB sherd. |
| 10 | 345440 E | 3624250 N | A complete carbonate flake, single facet platform, 100% dorsal cortex, 37 x 8 mm. |
| 11 | 345345 E | 3624160 N | A sandstone bifacial slab metate fragment |
| 12 | 345110 E | 3624255 N | A complete dull chert flake fragment, single facet platform, no cortex, 42 x 11 mm. |
| 13 | 344985 E | 3624220 N | A glossy chert distal flake fragment, no cortex, 3 mm thick. |
| 14 | 344710 E | 3624195 N | A complete flake of black glossy chert, cortical platform, 10% cortex, 50 x 11 mm. |
| 15 | 344160 E | 3624150 N | Two UB sherds. |
| 16 | 343723 E | 3624070 N | A complete limestone flake, single facet platform, 25% cortex, 44 x 14 mm and another complete limestone flake, 10% cortex, multifacet platform, 56 x 18 mm. |
| 17 | 342965 E | 3263960 N | A complete black chert flake, obliterated platform, no cortex, 47 x 8 mm. |
| 18 | 342870 E | 3623380 N | Two UB sherds, 1 piece of fire-cracked rock and a dull chert proximal flake fragment, prepared platform, 3 mm thick. This may be part of a buried site only slightly impacted by the construction. |
| 19 | 346745 E | 3624400 N | A glossy chert flake, single facet platform,no cortex, 23 x 4 mm. |
| 20 | 348010 E | 3624840 N | A sandstone slab metate fragment. |
| 21 | 348070 E | 3624850 N | A sandstone basin metate fragment. |

tion or illicit excavation activities is being undertaken.

An attempt to close the archeologically sensitive portions of the Jornada Range seems to be merited, based on these observations. Such closure might include overhauling the existing gates, erecting new fences and gates, and policing of the sensitive areas by both White Sands and Jornada Range personnel.

Impacts to LA 55341 by pipeline construction have been substantial and, based on the artifact density and the extensive midden exposed, testing would probably expose walls and other features within the disturbed area. Additionally, the high number of pushes along the bulldozed road in this area has substantially increased impact to this site. Testing and detailed mapping of the disturbed portion of the site is important, since it will be difficult to interpret the disturbed area once revegetation and eolian redeposition have occurred. The remaining lithic and ceramic scatters are at least partially buried, and further work will be required to determine the extent of impact caused by pipeline construction to these sites. This matter clearly indicates that consultation with the State Historic Preservation Officer is necessary.

The role of the Jornada Experimental Station in protecting cultural resources needs to be re-examined. Such a re-examination should lead to a cultural resource program for identifying and evaluating the important resources on the range as well as more active protection, renewed interest, and additional research into the archeology of the area.

## The Orogrande Alternative

The Orogrande Alternative location for the GBFEL-TIE Project falls near the southern end of the Tularosa Basin some 35 mi (56.3 km) southwest of Alamogordo, New Mexico. The location is bounded to the south by Nike Boulevard, which separates White Sands Missile Range from Fort Bliss Military Reservation. Just east of the the eastern border of the Orogrande Alternative are the Jarilla Mountains. The small town of Orogrande lies approximately 5 mi (8.1 km) southeast of the study area.

The entire Orogrande Alternative location falls within the Border Star 85 maneuver area, which was surveyed as part of the Border Star 85 Archeological Project conducted by OCA (Seaman et al. 1986). The Border Star 85 survey documented slightly fewer than 700 archeological sites within the GBFEL-TIE Orogrande Alternative area. The Border Star 85 survey, however, was a nonsite survey. The systematic transect recording strategy of the survey design severely limited the amount of site-specific information documented for properties encountered by the survey.

One result of the Border Star 85 methodology is that many sites, especially small sites, may have slipped through the 33 1/3 m spacing of the transects. Additionally, evidence indicates the presence of a significant number of buried sites (not visible on the surface) and therefore not recorded by the Border Star 85 survey. This evidence is found mostly along road cuts and in arroyos where disturbance has exposed buried hearths and artifact scatters.

Most of the sites encountered by the Border Star survey within the GBFEL–TIE Orogrande Alternative area are surprisingly uniform. With the exception of a few moderately sized sites that are somewhat concentrated near the eastern edge of the Orogrande area, most of the sites are small lithic artifact or lithic artifact and ceramic scatters exposed in deflated areas between the large and small coppice dunes that cover nearly the entire area. For the most part these sites are signaled by scatters or concentrations of fire–cracked rock. Much of the fire–cracked rock is volcanic porphyry, presumably brought into the basin from the nearby Jarilla Mountains. A few relatively large areas (up to 1 km$^2$ ) without sites exist within the Orogrande Alternative area, but these areas also roughly correspond to nearly level grasslands or filled–in playas, which may well contain buried sites as a result of recent continued alluviation.

The preliminary drilling program for the Orogrande Alternative specified drill holes at 16 locations indicated in (Figure A3.3). Since the drilling locations were placed independently of the existing roads, new roads were graded to provide access for the drill rigs and water trucks. The soft sand proved to be a major impediment to access for the water trucks even along the graded roads, and, over the course of the entire project, three driveshafts were broken on the water trucks and had to be replaced.

The proposed drilling sites were located using 1:50,000 and 1:10,000 scale maps and 1:3000 scale aerial photographs. The location of the proposed drill holes had been staked and flagged, but since many of the locations were more than a kilometer from the nearest road, considerable searching was required to find them. While walking out to find the drilling locations, care was taken to note site areas to be avoided by the access route. After the drilling locations had been found, a 20–40 ft (6-12 m) wide right–of–way was flagged for later grading and by the drilling equipment. Sites located along the access route were marked for avoidance by stretching flagging tape between two coppice dunes.

In all, 7 of the 16 drilling locations had to be offset from their proposed locations. Two were moved because archeological sites were located on or around the proposed location. Three were moved because high coppice dunes prevented easy access to the proposed location, and two were moved to prevent damage to environmentally sensitive playa areas.

The disturbance associated with the grading and drilling activities was considerable. During grading activities many off–road pushes were required to remove loose sand from the graded roads. Such pushes involve moving nearly all the loose sand and often most of the original vegetation well off the road. Pushes involve disturbance up to 20 ft (6 m) from the road being graded. The new "dunes" created by pushes are generally between 3 ft (0.9 m) and 5 ft (1.5 m) high, but in particularly sandy areas and especially where the new roads meet the already established roads, the new dunes created by the heavy equipment can reach 10 ft (3.0 m) in height.

Considerable disturbance also occurred at nearly all the actual drilling locations. At each location a 3–4 ft (0.9–1.2 m) deep sump was dug to hold the water and mud necessary for drilling. When drilling was completed, the sump was backfilled and the entire drilling location was leveled by an 8 ft (2.4 m) CAT front–end loader.

In all, 4 mi (6.4 km) of new roads were graded in the Orogrande Alternative area, and two new sites (not previously discovered by the Border Star 85 survey) were found during clearance activities along the access routes. After drilling was completed and the drilling teams had moved on to the NASA Alternative area, all the access roads and drilling locations were resurveyed to look for cultural material either missed during the original survey or churned up during grading or use of the road by the drilling equipment.

The results of the resurvey indicate that the monitoring and clearance project was highly successful in preventing damage to cultural resources in the Orogrande area. The resurvey was conducted after at least three periods of heavy rain. All the drilling locations and newly graded roads were resurveyed, and only two Unspecific Brownware sherds and one fragment of fire–cracked rock were found. These artifacts were found in the graded road in an area that looked as though it had once been deflated and had started to backfill. No additional cultural material was visible on the surface within the still slightly deflated area outside the graded road. This material was quite possibly part of a small site that lies buried between the high coppice dunes in this area.

The more than 6.4 km (4 mi) of new roads graded into [illegible] Orogrande Alternative area present possible future [illegible]oblems both to the general environment and to the archeology of the area. The principal cause for concern is the ongoing use of the Border Star 85 area for tank maneuvers by personnel and equipment from Fort Bliss. These maneuvers are generally restricted to existing roads and trails, and the new roads will almost certainly attract additional impacts. The principal problem with the use of these new roads is that all of them are dead ends and many stop just short of archeological sites or environmentally sensitive playa areas. Closing of the roads by erecting substantial berms at the intersections of the previously existing and the newly graded roads is

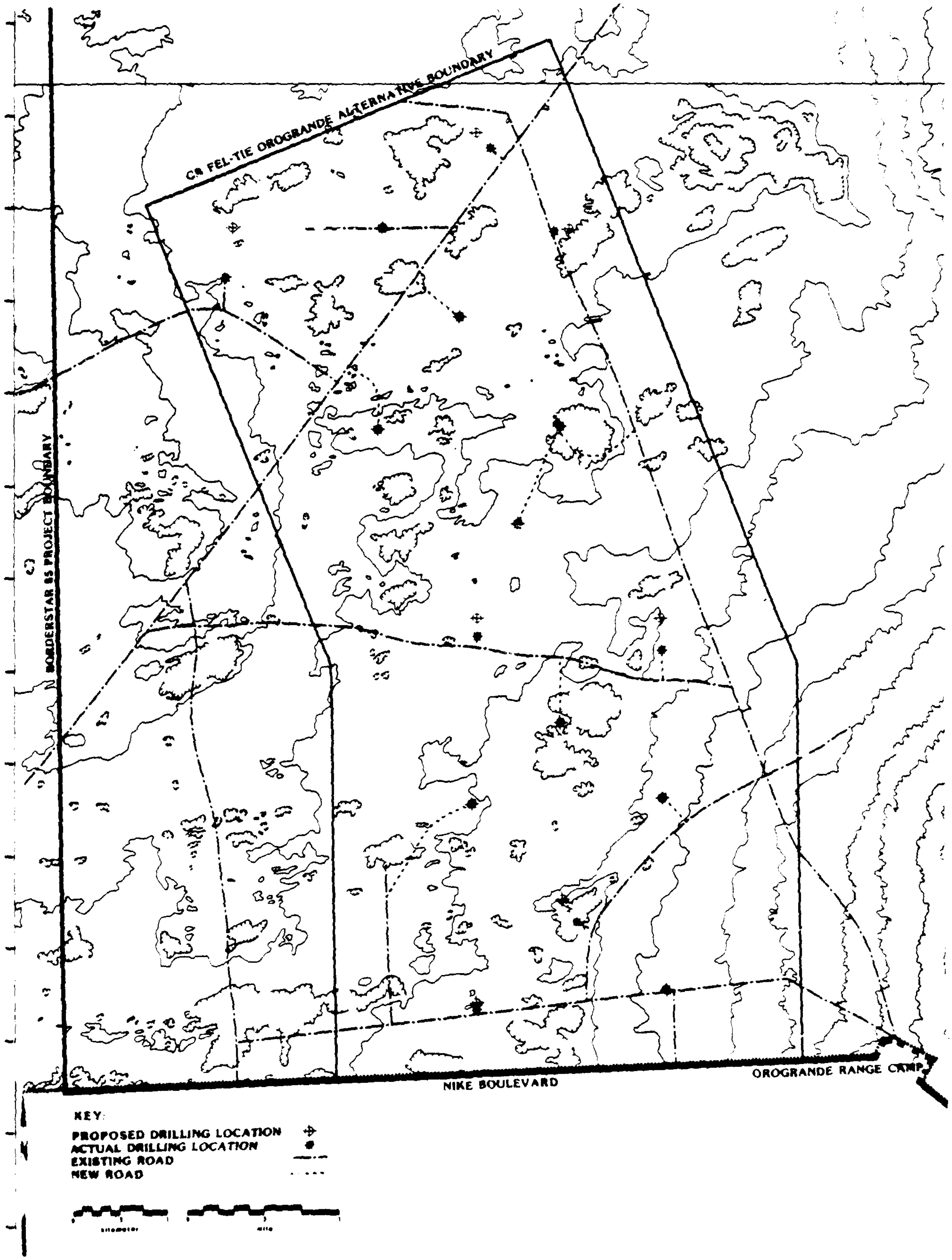



Figure A3.3. Orogrande Alternative monitoring locations and archeological sites.

recommended, if military maneuvers continue in the White Sands portion of the Border Star 85 maneuver area.

## Conclusions and Remarks

The monitoring program of the preliminary geotechnical assessment of the three alternatives for the GBFEL–TIE project was very successful in preventing damage to archeological sites in each of the three alternatives. A high level of cooperation between the U.S. Army Corps of Engineer's drilling teams and the archeologists was achieved and maintained during the entire project. The willingness displayed by the CE personnel to accept and abide by the advice offered by the supervising archeologist, enabled him to maintain a casual approach to overseeing the drilling activities, which significantly reduced downtime. Much of the credit for the successful completion of this project goes to Andrew Parker of the CE's Mobile office. His understanding of the importance of cooperating in the protection of the cultural resources in the three areas is much appreciated.

Discussions with the drilling crews and geologists working on the project indicate that, once the final site selection for the GBFEL–TIE project is made, extensive geotechnical studies involving up to 500 additional holes will be required. Since these holes will need to be placed more precisely than the just completed preliminary holes, the archeological survey and some data recovery should be completed before the drilling teams begin work. Once a construction site is selected, dovetailing the archeological work with the access requirements of the drilling plan will probably be one of the first problems encountered. It will be important to have arrangements made for the survey as quickly as possible after a final decision is made. Also, should the CE employ a private drilling contractor, the possibility of delays due to archeological efforts should be made clear from the outset, to ensure cooperation between any monitors working on the drilling project and the private contractors.

Appendix 3 Attachment

# SITE RECORDS

GENERAL DATA SHEET Page 1 of ____

Project GB-FEL-TIE Recorder P.T. Noyes Date 7/3/86

Field Number OCA:50? LA Number 55337

Map Reference Goldenburg Draw 7.5' County Dona Ana State NM

Aerial Photo Number N/A Land Status Jornada Range (USDA)

Location: S½ of SW ¼ of NE ¼ and N½ of NW¼ of SE¼ Sec 13, T 18S, R 2E

UTM Zone 13, 3 4 1 8 0 0 E, 3 6 2 3 8 0 0 N

Physical Environment:

Elevation 4740 feet (x 0.305=) ____ meters

| Slope: | Up/Down/Flat | Inclination | | Up/Down/Flat | Inclination |
|---|---|---|---|---|---|
| | Flat | | | | |
| North | | | East | | |
| South | | | West | | |

Exposure: N ___ NE ___ E ___ SE ___ S ___ SW ___ W ___ NW ___ 360 x

Landform Dune field Description ____

Soil Fine and medium-grained subangular sand

Drainage: Primary New Well Draw Secondary ____

Nearest Potential/Permanent Water New Well Draw Distance ____

Biotic Environment:

Vegetation: Regional Mesquite shrub Local ____

Species Prosopsis, Gutierrezia, Yucca

Fauna N/A

Site Type:

Structural ____ Non-structural x

Cultural/Temporal Designation Archaic/El Paso Phase

Characteristics:

Dimensions 225 x 100 m Orientation E-W

Condition Wind and water (runoff) disturbance

Depth of Deposition unknown How Determined ____

Photographs:

B/W roll number N/A frames ____ Color roll number ____ frames ____

Forms Attached:

Inventory ____ Provenience ____ Plan ____ Profile ____ Artifact ____

page 2 of

GENERAL DATA SHEET Field No. OCA:501 LA No. 55337

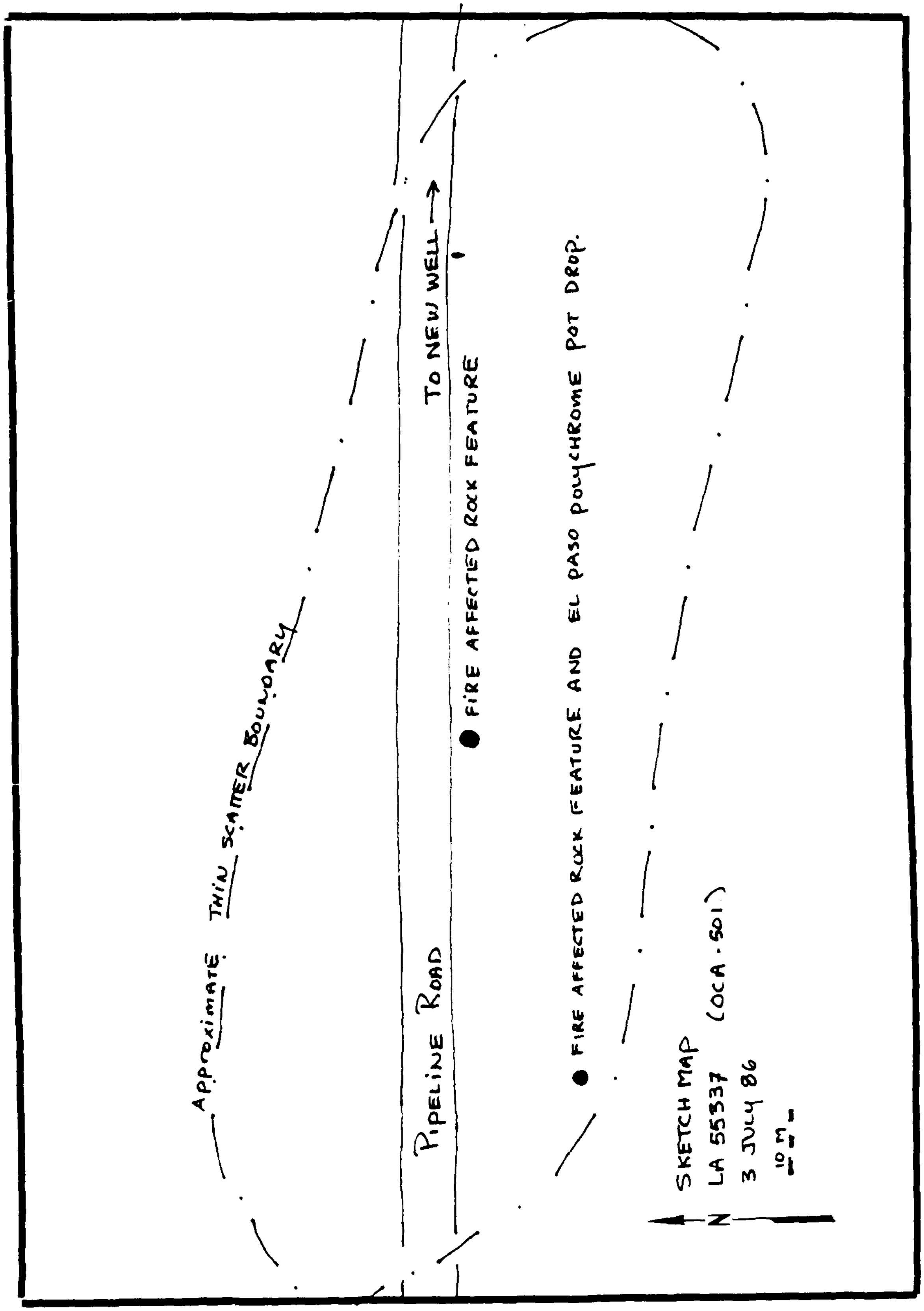
*****Use this space for continuations of data from Page 1, and for a paragraph which describes the cultural phenomena observed in the location and contexts described on Page 1.

Comments:

(i.e. number, kind, size, shape, age, condition, etc., etc., etc...........)

LA 55337
(site 501)

This site is a large diffuse lithic scatter with at least two fire-cracked rock concentrations. The site is located in a nearly level and somewhat stabilized dune field dominated by mesquite interspersed by snakeweed and yucca. Cultural material is exposed in shallow deflated areas and along the newly graded road. The material is not dense but appears as two to five artifacts scattered in several adjacent exposures. Many artifacts probably remain buried. Three unifacial artifacts, one El Paso Polychrome pot drop, and several ground stone fragments were noted on the site. The pot drop appears to be associated with one of the fire-cracked rock concentrations near the southwestern corner of the site. The site is probably multicomponent used during the archaic and El Paso Phase.


Approximate THIN SCATTER BOUNDARY
PIPELINE ROAD
TO NEW WELL →
FIRE AFFECTED ROCK FEATURE
FIRE AFFECTED ROCK FEATURE AND EL PASO POLYCHROME POT DROP.
FIRE AFFECTED ROCK FEATURE
SKETCH MAP
LA 55337 (OCA-501)
3 JULY 86
10 M
N

GENERAL DATA SHEET Page 1 of ____

Project GB-FEL-TIE Recorder P.T. Noyes Date 7/3/86

Field Number OCA:502 LA Number 55338

Map Reference Goldenburg Draw 7.5' County Dona Ana State NM

Aerial Photo Number N/A Land Status Jornada Range (USDA)

Location: SW ¼ of NE ¼ of NW ¼ of Sec 16, T 18S, R 3E

UTM Zone 13, 3 4 6 1 3 0 E, 3 6 2 4 3 2 0 N

Physical Environment:

Elevation 4975 feet (x 0.305=) ____ meters

| Slope: | Up/Down/Flat | Inclination | | Up/Down/Flat | Inclination |
|---|---|---|---|---|---|
| North | | | East | | |
| South | | | West | | |

Exposure: N x NE x E x SE ___ S x SW x W x NW x 360 x

Landform Dune field Description Near a set of low foothills to the San Andres Mountains

Soil Fine and medium-grained subangular sand

Drainage: Primary New Well Draw Secondary ____

Nearest Potential/Permanent Water New Well Draw Distance ____

Biotic Environment:

Vegetation: Regional Mesquite shrub Local ____

Species Prosopsis, Gutierrezia, Yucca

Fauna N/A

Site Type:

Structural ____ Non-structural x

Cultural/Temporal Designation Archaic

Characteristics:

Dimensions 48 x 55 m Orientation N/S

Condition Wind disturbed

Depth of Deposition 30 cm How Determined estimated

Photographs:

B/W roll number N/A frames ____ Color roll number ____ frames ____

Forms Attached:

Inventory ____ Provenience ____ Plan ____ Profile ____ Artifact ____

page 2 of ____

GENERAL DATA SHEET Field No. OCA:502 LA No. 55338

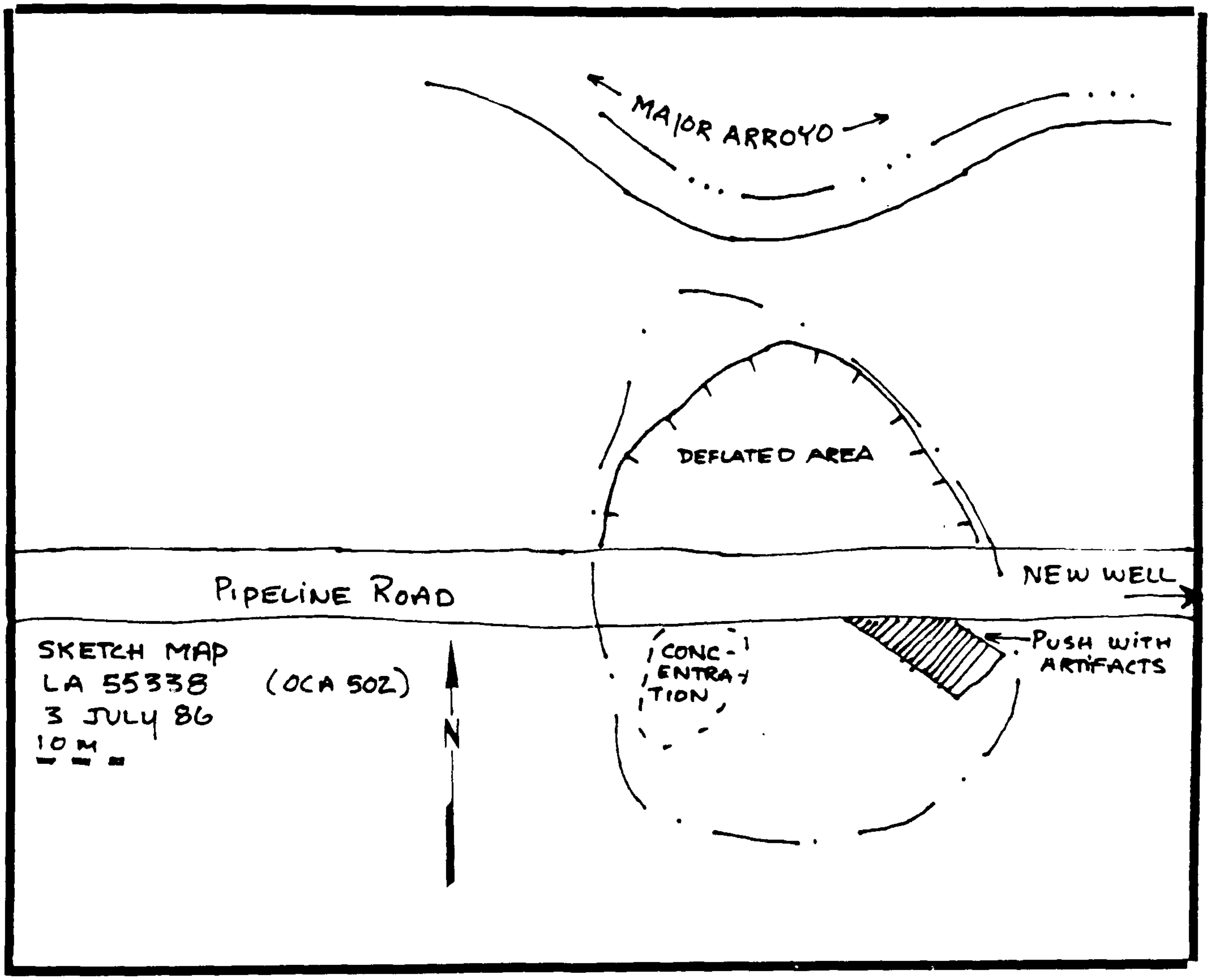
*****Use this space for continuations of data from Page 1, and for a paragraph which describes the cultural phenomena observed in the location and contexts described on Page 1.

Comments:

(i.e. number, kind, size, shape, age, condition, etc., etc., etc...........)

LA 55338
(site 502)

This site is a small archaic lithic scatter located approximately 10 m south of a steep-sided tributary wash to New Well Draw. The site is exposed on the surface on both sides of the recently graded New Well pipeline road. The dominant lithic material is white glossy chert accompanied by limestone, quartzite, and glossy blue-gray chert. A thin scatter of fire-cracked rock is present over most of the site area. No ground stone was noted at the site, but several bifacial thinning flakes as well as several flakes with prepared platforms were observed. A slight lithic concentration was noted immediately south of the disturbed road area.


MAJOR ARROYO
DEFLATED AREA
PIPELINE ROAD
NEW WELL
CONC-
ENTRA-
TION
PUSH WITH
ARTIFACTS
SKETCH MAP
LA 55338 (OCA 502)
3 JULY 86
10 M
N

GENERAL DATA SHEET Page 1 of ___

Project GB-FEL-TIE Recorder P.T. Noyes Date 7/3/86

Field Number OCA:503 LA Number 55339

Map Reference Goldenburg Draw 7.5' County Dona Ana State NM

Aerial Photo Number N/A Land Status Jornada Range (USDA)

Location: SE ¼ of NE ¼ of NW ¼ of Sec 16, T 18S, R 3E

UTM Zone 13, 3 4 6 1 3 0 E, 3 6 2 4 3 2 0 N

Physical Environment:

Elevation 5000 feet (x 0.305=) ________ meters

| Slope: | Up/Down/Flat | Inclination | | Up/Down/Flat | Inclination |
|---|---|---|---|---|---|
| North | | | East | | |
| South | | | West | | |

Exposure: N x NE x E x SE ___ S x SW x W x NW x 360 ___

Landform ________ Description ________

Soil Fine and medium-grained subangular sand

Drainage: Primary New Well Draw Secondary ________

Nearest Potential/Permanent Water New Well Draw Distance ________

*Biotic Environment:*

Vegetation: Regional Mesquite shrub Local ________

Species Prosopsis, Gutierrezia, Yucca

Fauna N/A

Site Type:

Structural ________ Non-structural x

Cultural/Temporal Designation Unknown, El Paso Phase ?

Characteristics:

Dimensions 50 x 60 m Orientation NW/SE

Condition Wind and water (runoff) disturbance

Depth of Deposition unknown How Determined ________

Photographs:

B/W roll number N/A frames ________ Color roll number ____ frames ____

Forms Attached:

Inventory ____ Provenience ____ Plan ____ Profile ____ Artifact ____

page 2 of

GENERAL DATA SHEET Field No. OCA:503 LA No. 55339

*****Use this space for continuations of data from Page 1, and for a paragraph which describes the cultural phenomena observed in the location and contexts described on Page 1.

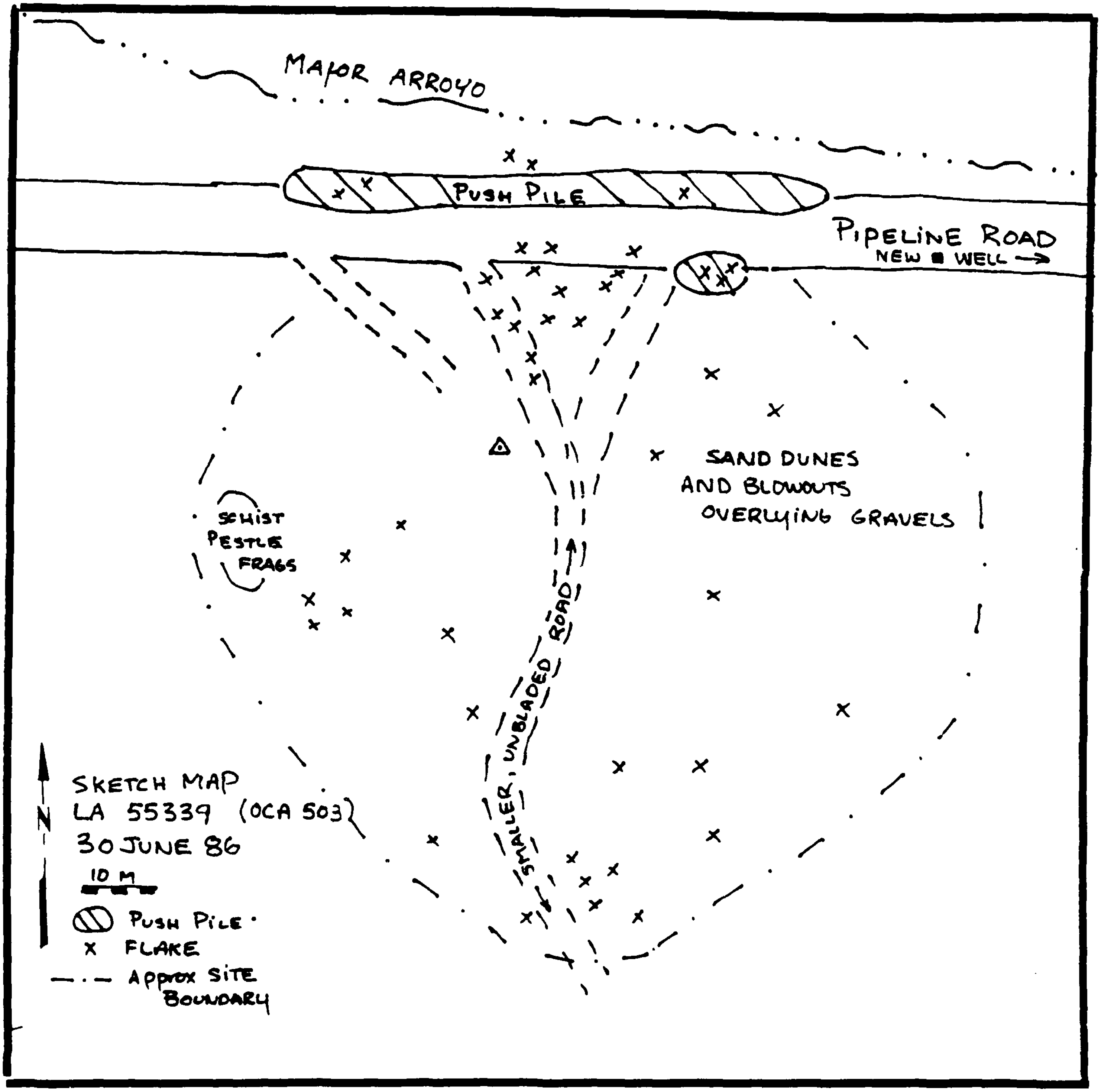
Comments:

(i.e. number, kind, size, shape, age, condition, etc., etc., etc............)

LA 55339
(site 503)

This site is a large, moderate density lithic and ground stone scatter which sits on a slight sand-covered knoll overlooking New Well Draw to the north and west. The site is located at the intersection of the recently created New Well pipeline road and a south tending road which skirts the edge of the prominant hills in the northwest quarter of section 16 (T18S, R3E). The dominant lithic material type is glossy white chert with only occasional carbonate flakes. Ground stone observed on the site includes sandstone mano and metate fragments and at least two schist pestle fragments. Concentrations of lithics, groundstone, and fire-cracked rock observed on the surface may be discrete activity or occupation areas.

The site has been disturbed by grading of the new road into New Well. Several three to five foot berms have been pushed up along portions of the new road and the regraded, south tending road. Fire-cracked rock and more than 25 flakes were noted on the surface of the disturbed portion of the road. The site could have been avoided by moving the pipeline and road about 25 m to the south.



MAJOR ARROYO
PUSH PILE
PIPELINE ROAD
NEW ■ WELL →
SAND DUNES
AND BLOWOUTS
OVERLYING GRAVELS
SCHIST
PESTLE
FRAGS
SMALLER, UNBLADED ROAD
N
SKETCH MAP
LA 55339 (OCA 503)
30 JUNE 86
10 M
PUSH PILE
x FLAKE
APPROX SITE
BOUNDARY

GENERAL DATA SHEET Page 1 of ____

Project GB-FEL-IIE Recorder P.T. Noyes Date 7/4/86

Field Number OCA:504 LA Number 55340

Map Reference Goldenburg Draw 7.5' County Dona Ana State NM

Aerial Photo Number N/A Land Status Jornada Range (USDA)

Location: NE ¼ of NE ¼ of NE ¼ of Sec 16, T 185, R 3E

UTM Zone 13, 3 4 7 4 5 0 E, 3 6 2 4 0 8 0 N

Physical Environment:

Elevation 5045 feet (x 0.305=) ____ meters

| Slope: | Up/Down/Flat | Inclination | | Up/Down/Flat | Inclination |
|---|---|---|---|---|---|
| North | | | East | | |
| South | | | West | | |

Exposure: N x NE x E x SE ___ S x SW x W x NW x 360 ___

Landform Dune ridge Description The site is located on the north-facing slope of a prominent hill in section 15, T18S, R3E

Soil Fine and medium-grained subangular sand

Drainage: Primary New Well Draw Secondary ____

Nearest Potential/Permanent Water New Well Draw Distance ____

Biotic Environment:

Vegetation: Regional Mesquite shrub Local ____

Species Prosopsis, Gutierrezia, Yucca

Fauna N/A

Site Type:

Structural ____ Non-structural x

Cultural/Temporal Designation Archaic

Characteristics:

Dimensions 100 x 60 m Orientation NW/SE

Condition Wind and water (runoff) disturbance

Depth of Deposition ____ How Determined ____

Photographs:

B/W roll number ____ frames ____ Color roll number ____ frames ____

Forms Attached:

Inventory ____ Provenience ____ Plan Profile ____ Artifact ____

page 2 of ____

GENERAL DATA SHEET  Field No. OCA:504  LA No. 55340

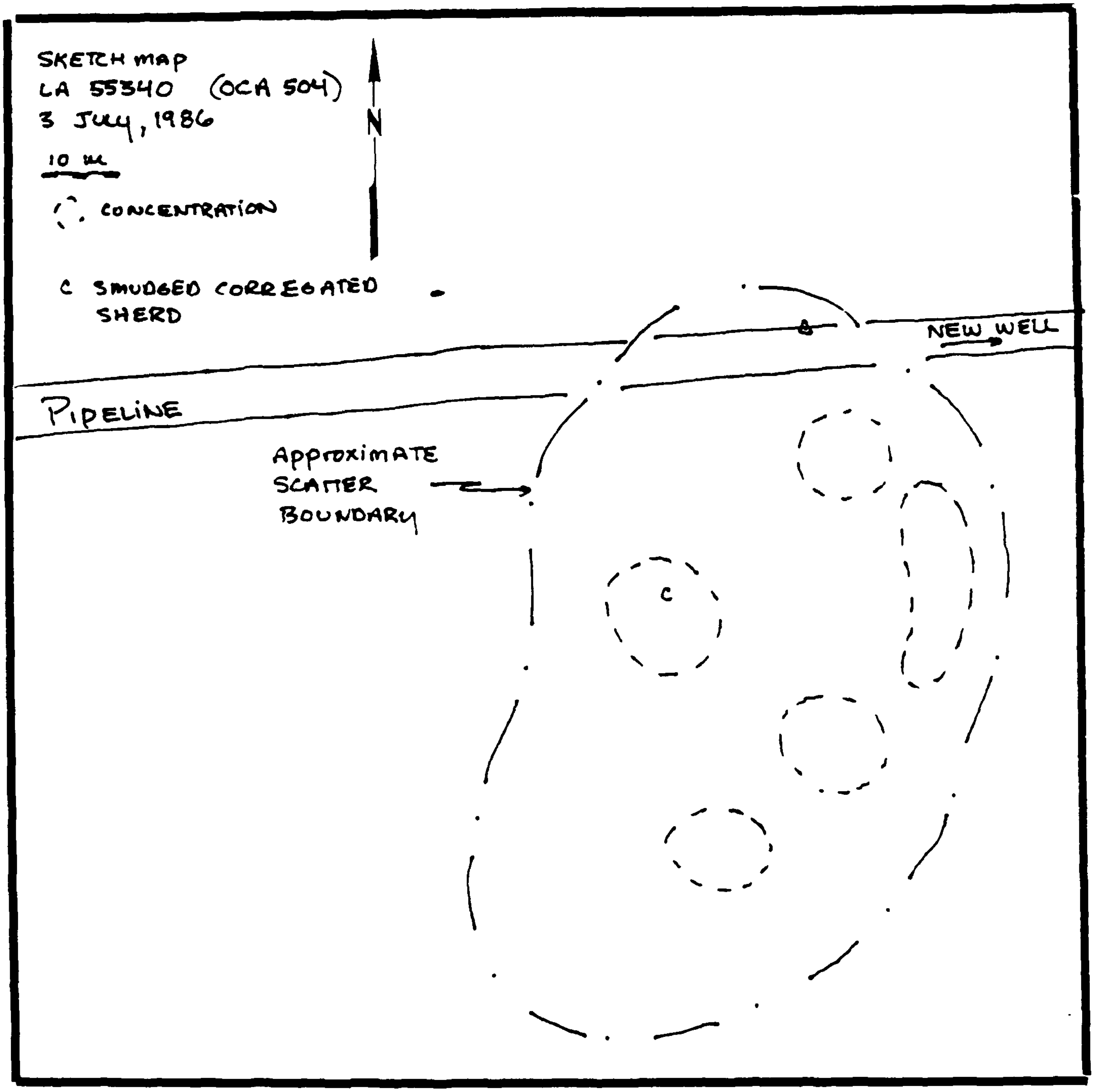
*****Use this space for continuations of data from Page 1, and for a paragraph which describes the cultural phenomena observed in the location and contexts described on Page 1.

Comments:

(i.e. number, kind, size, shape, age, condition, etc., etc., etc...........)

LA 55340
(site 504)

This site is an occasionally dense lithic scatter located in sands and gravels on the north slope of a slight ridge that extends north off a prominant hill topward New Well Draw. White glossy chert is the dominant lithic material, but limestone flakes are also present as well as gray glossy chert and cream-colored chert. Also present on the site are a single schist pestle fragment, numerous fire-cracked rocks, and a single corrugated-smudged brownware sherd. The site is located only 200 m east of an extensive El Paso Phase village site (LA 55341), and it may be a continuation of that site or an earlier site that was reused by the El Paso Phase inhabitants of the area. Although the site is visible on both sides of the recently created New Well pipeline road, most of the site is located south of the road and cultural material is not concentrated north of the road.


SKETCH MAP
LA 55340 (OCA 504)
3 JULY, 1986
10 m
CONCENTRATION
C SMUDGED CORREGATED SHERD
N
PIPELINE
NEW WELL
APPROXIMATE SCATTER BOUNDARY
C

GENERAL DATA SHEET Page 1 of ___

Project GB-FEL-TIE Recorder P.T. Noyes Date 7/4/86

Field Number OCA:505 LA Number 55341

Map Reference Goldenburg Draw, Fleck Draw, Gardner Peak County Dona Ana State NM

Aerial Photo Number ___ Land Status Jornada Range (USDA)

Location: SW ¼ of SW ¼ of ___ ¼ of Sec 10 , T 18S , R 3E

UTM Zone ___, 3 4 7 1 0 0 E, 3 6 2 4 6 0 0 N

Physical Environment:

Elevation 5040 feet (x 0.305=) ___ meters

| Slope: | Up/Down/Flat | Inclination | | Up/Down/Flat | Inclination |
|---|---|---|---|---|---|
| North | | | East | | |
| South | | | West | | |

Exposure: N ___ NE ___ E ___ SE ___ S ___ SW ___ W ___ NW ___ 360 x

Landform ___ Description ___

Soil Fine and medium-grained subangular sand

Drainage: Primary New Well Draw Secondary ___

Nearest Potential/Permanent Water New Well Draw Distance ___

Biotic Environment:

Vegetation: Regional mesquite shrub Local same

Species Prosopsis, Gutierrezia, Yucca

Fauna N/A

Site Type:

Structural x Non-structural ___

Cultural/Temporal Designation El Paso Phase

Characteristics:

Dimensions 500 x 250 m Orientation E-W

Condition Intact, disturbed by recent construction

Depth of Deposition 1-2 m How Determined estimated

Photographs:

B/W roll number N/A frames ___ Color roll number ___ frames ___

Forms Attached:

Inventory ___ Provenience ___ Plan ___ Profile ___ Artifact ___

page 2 of ____

GENERAL DATA SHEET    Field No. OCA:505    LA No. 55341

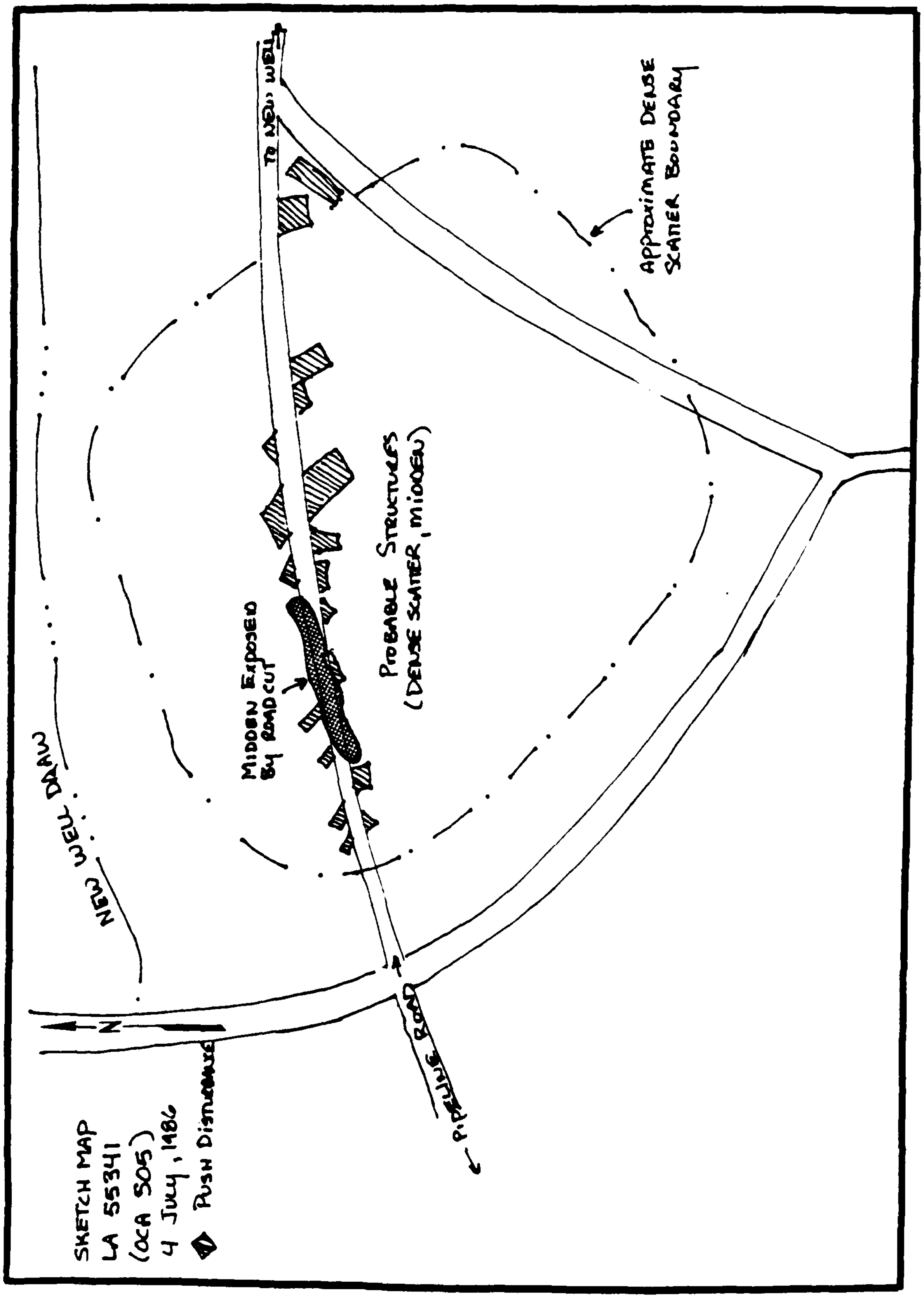
*****Use this space for continuations of data from Page 1, and for a paragraph which describes the cultural phenomena observed in the location and contexts described on Page 1.

Comments:

(i.e. number, kind, size, shape, age, condition, etc., etc., etc...........)

LA 55341
(site 505)

The site is an EL Paso Phase Village site located on a sand-covered bench immediately south of New Well Draw approximately .75 mi west of New Well. The site was located during the survey of a recently constructed pipeline and bulldozed road which runs from New Well to a new set of water tanks located some 6 mi east of New Well. The placement of the pipeline and the bulldozing of the road have exposed more than 35 linear m of dark midden and cultural material. The impact of the pipeline and road construction is compounded by more than 20 "pushes" of sand and vegetation up to 20 m away from the pipeline. Ceramics noted on the site include El Paso Polychrome, El Paso Bichrome, Undifferentiated Brownware, Corrugated-Smudged Brownware, Mogollon Brownware, Chupadero Black on White, Lincoln Black on Red, Playas Incised (local variant?), Ramos Black, Mexican Polychrome (Ramos?), Gila Polychrome, Three Rivers Red on Terracotta, Rio Grande Glaze A, Mimbres style one or two, and several unknown types.


SKETCH MAP
LA 55341
(OCA 505)
4 JULY, 1986
PUSH DISTURBANCE
N
NEW WELL DRAW
TO NEW WELL
MIDDEN EXPOSED
BY ROADCUT
PROBABLE STRUCTURES
(DENSE SCATTER, MIDDEN)
APPROXIMATE DENSE
SCATTER BOUNDARY
PIPELINE ROAD

Appendix 4

# A CONSIDERATION OF EIDENBACH'S (1982) RESOURCE EVALUATION SCHEME

Richard C. Chapman

## Introduction

One provision of the fieldwork documentation required by the CE for the GBFEL-TIE sample survey effort was an attempt to utilize a formal significance rating system. A significance evaluation system developed by P. L. Eidenbach (1982:337-366) was prescribed by the CE. This system was evaluated prior to fieldwork, and it was determined that nearly all data required by the system were either already treated by the recording forms being developed for the survey or were not realistically obtainable through field observations alone. This appendix constitutes the results of our evaluation of the utility of the system. For an extensive explanation of the scheme itself, the interested reader is referred to Eidenbach (1982).

From a strictly philosophical standpoint, the significance evaluation strategy proposed by Eidenbach (1982) is clearly stimulated by a fundamental concern to establish a *relative* scale of significance of cultural resources as defined by criterion "d" of 36CFR60.6 of the National Historic Preservation Act of 1966 (as amended):

> Unfortunately, subsection (d) seldom discriminates beyond the often arbitrary alternatives "non-significant" and "significant." While this distinction may be sufficient for initial nomination procedures, it is clearly inadequate for long term management, protection and utilization of significant cultural properties [Eidenbach 1982: 337].

Eidenbach amplifies this concern by referring to a distinction between a *research* model of significance and the *resource* model of significance originally proposed by Merlan (1981: 345-356). He specifically quotes Merlan's statements that significance based on the research model "will rise and fall as questions are answered and asked" (Merlan 1981: 393); and goes on to state that "The application of 36FC60.6(d) is sufficient to answer the requirements of the Research Model" (Eidenbach 1982: 338).

It seems clear from the tenor of Eidenbach's discussion, however, that he is philosophically dissatisfied with a potentially shifting *research* framework through which significance is evaluated and wishes to establish a more empirical *resource* -based model for such evaluation.

It can be suggested, however, that Merlan's initial conceptualization of the resource model is equally dynamic, in that he explicitly recognizes the changing physical nature of the environment and the changing effects of human activity in the destruction and creation of sites (Merlan 1981: 352-353). As articulated by Merlan, the resource model of significance has a decided managerial referent, and it is the interplay of research concerns as they apply to physical properties of the resource which needs to be addressed:

> This brings us back to our point of departure. Significance is a formula, but a formula with a practically unlimited number of terms. The formula is not fixed... We, of course, are not too upset about learning that the quality of significance is pervasive and not to be isolated, and that there appears to be no end to the work we are doing. We suspected as much [Merlan 1981: 354].

We believe this debate clearly demonstrates that the determination of significance does, in fact, take into consideration the empirical nature of cultural resources as a part of the decision-making formula. We would argue that the process of compliance, as it is now undertaken in the State of New Mexico, requires active, careful evaluation of both the research potential and the physical properties of cultural resources in terms of their potential for providing significant information of importance to prehistory. It can be amply demonstrated through a review of survey reports, concurrence letters, testing programs, and subsequent actions that the process through which cultural resources are identified, described, subjected to scrutiny, and ultimately treated is a healthy, dynamic, and intellectually charged exercise. Thus we believe that philosophical concerns charging that the physical character of the resource is not being taken into consideration when making determinations of significance are without foundation.

## The Evaluation Scheme

Eidenbach proposes 23 categories of information (variables) to be gathered in his resource evaluation scheme, and states "the system restricts observational and judgmental variables to those which can be evaluated in a typical field survey situation..." (Eidenbach 1982: 338). He explicitly states that the scoring system offers (among

other advantages) "formally defined and consistent observational and judgmental data categories" (ibid).

In light of this, each of the 23 variables will be evaluated to see if it meets two criteria: 1) can the variables be assigned in the field during survey, and 2) can the variables be consistently applied in a field setting?

**Registry and Management Data (Eidenbach 1982:339):**

1) *A number:* normally a post–field exercise; is consistent.

2) *Site number:* can be assigned during fieldwork; is consistent.

3) *Owner:* can be assigned during survey; not necessarily consistent.

**Basic Site Descriptive Data (Eidenbach 1982:339–341):**

4) *Horizon (estimated temporal horizon):* Eidenbach (1982: 339) offers 18 temporal codes to reflect "the estimated temporal horizon, or period of site occupation" (1982:339). This is clearly a post–field analytically based judgment and cannot be applied consistently in the field.

5) *Site type:* This variable is a brief, descriptive term for the apparent type of site. This can be done in the field, but not necessarily in a consistent fashion.

6) *Cultural Litter Density (CLD):* As an average density of measured spatial sample units, this variable can be calculated in the field, but to prevent error, is best calculated from data sheets in post–field contexts.

7) *Density:* This variable represents a comparative judgment of the degree of artifact density among the sites reported in the actual sample. As such, a judgment could certainly be made in the field, but would be, just as certainly, inconsistent.

8) *Depth:* Field judgments of depth from surface observations alone can be (and often are) notoriously inaccurate. Subjective estimates of depth in landforms characterizing the GBFEL–TIE alternatives cannot be used as reasonable planning information.

9) *Area (maximum surface area of site deposits):* Actual calculations of surface area are generally made from measurements taken in the field or from site maps. This can be consistently achieved during fieldwork.

10) *Surface integrity:* This variable is intended to monitor the intensity of all forms of surface disturbance resulting from both natural processes like erosion and human activities, plowing, vehicular travel, etc. Previous discussion in Chapters 2 and 4 of this report amply demonstrate the fact that it is impossible to assess relative surface integrity in the GBFEL–TIE environmental settings.

11) *Stratigraphy:* This code scores the presence or absence of stratigraphy within site deposits and specifies whether the observation is based on direct or indirect evidence. Again, based on the geomorphological contexts of the GBFEL–TIE alternatives, no relative evaluation of stratigraphy could be made in the field.

12) *Context:* The context of cultural materials in site deposits attempts to monitor the nature of stratigraphic preservation of those deposits. As with estimates of stratigraphy, geomorphological contexts of site locations on the GBFEL–TIE alternatives made any field judgments highly questionable.

**Comparative Evaluation Data (Eidenbach 1982:341–344)**

Variables 13 through 23 in this evaluation scheme are clearly post–field, analytically–derived variables that cannot be reliably or consistently identified in field survey contexts. Additionally, Variables 14–22 (*rarity by period, rarity of site type, rarity of artifact/architectural forms, maximum degree of preservation, potential for restoration, aesthetic value, potential for formal artifact studies, potential for intrasite distributional studies, and potential for temporal/chronometric studies*) are all to be scaled in differing frames of reference identified in Variable 13 (such as local vs regional vs state levels of spatial frames of reference, or phase–specific temporal frames of reference).

Such shifting criteria, while perhaps appropriate as an analytical phase after fieldwork is completed, are clearly inappropriate for field decision making, with the possible exception of Variable 19 (*aesthetic value*).

In reviewing the effectiveness and consistency of the comparative resource evaluation scheme proposed by Eidenbach, it can be stated unequivocally that the vast majority of variables cannot be adequately scored during the course of surface survey activities. Variables 4, 5, and 13–22 require post–field comparative analysis in order to be scored, while Variables 8, 10, 11, and 12 require a concurrent subsurface testing program if they are to be reliably scored.

In terms of post–field analysis, a final problem with the comparative evaluation scheme becomes immediately apparent: the cumulative weighing of scores both artificially and profoundly biases the results in favor of higher significance values for cultural resources which exhibit architectural features. Thus sites with clear evidence of architecture de facto score higher on Variables 18 and 19, and most probably will score higher on all variables related to depth, stratigraphy, and preservation (Variables 8, 11, 12). Additionally, because of the additive presence of architectural features, such sites have a greater probability of scoring higher on many comparative variables related to "rarity" or "potential for studies" (Variables 14, 15, 16, 20). Therefore, from a strictly logical standpoint, it can be argued that the proposed scoring

system introduces an unacceptable bias in evaluating significance.

## Application of the Evaluation Scheme

The attempt to utilize Eidenbach's evaluation system in the field was done through specifying those variables that did have some realistic potential for reliable and consistent observation on the site data forms. Consequently, Variables 2, 6, 8, 9, 10, and 23 were directly monitored in the field; data appropriate for scoring Variables 4, 5, 7, 14, 15, 16, 19, 20, 21, and 22 were collected. Variables 1 and 3 were of course added in the lab.

Due to the considerable liabilities in attempting to use the system (as outlined above), coupled with the geomorphological character of the Stallion, NASA and Orogrande Alternatives, the scheme, as proposed, could not be implemented in the field.

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